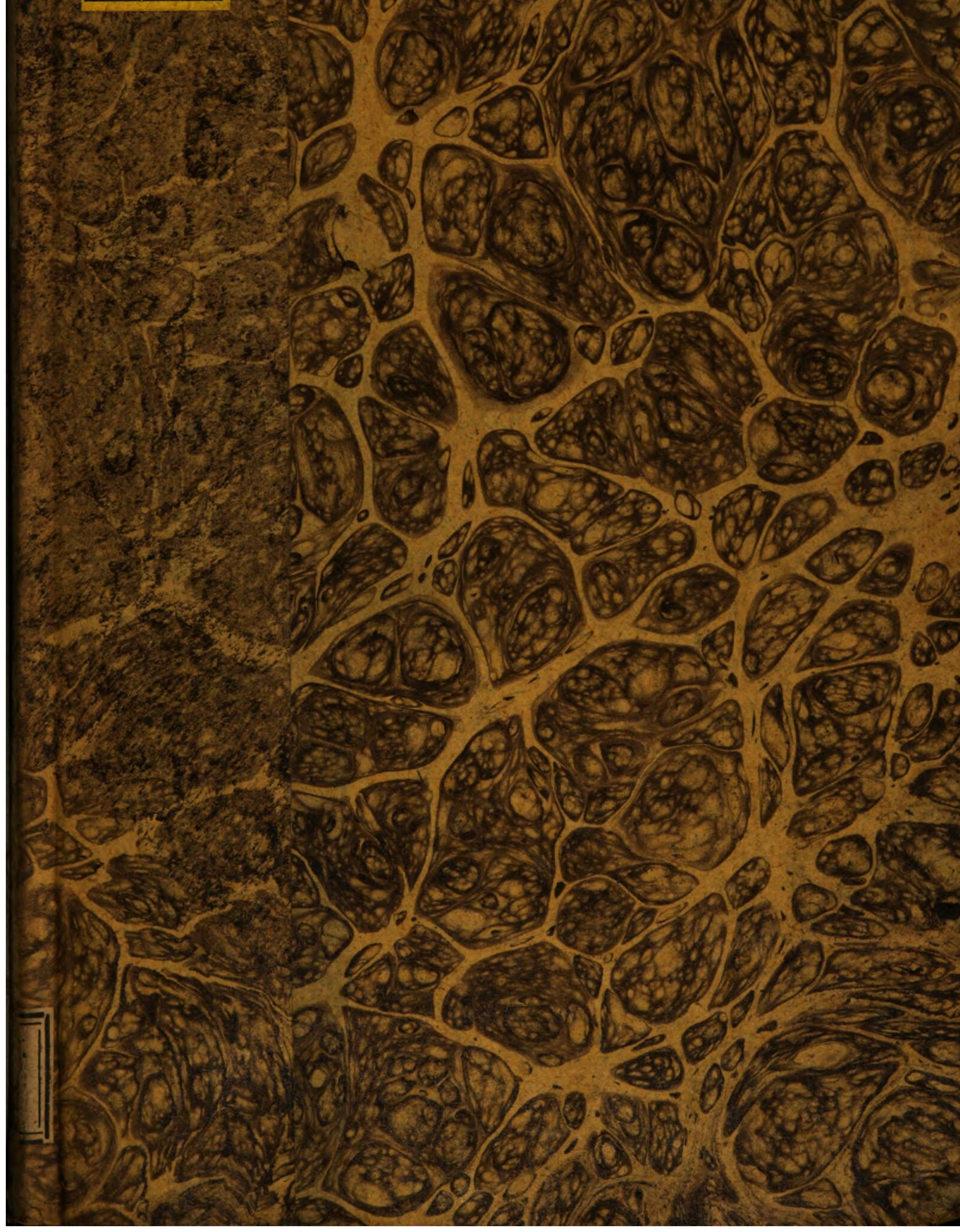




after P. 48.

AN
ESSAY
TOWARDS A HISTORY OF THE
PRINCIPAL COMETS
THAT HAVE

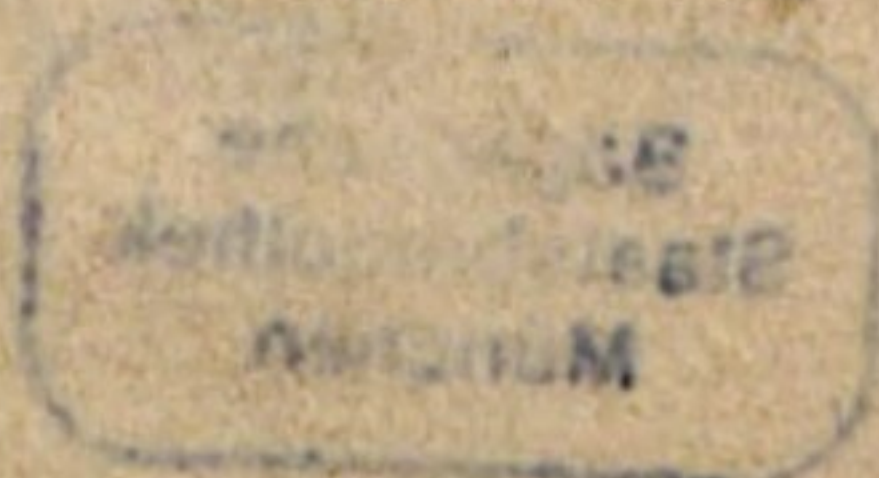
APPEARED SINCE THE YEAR 1742.

Including a particular Detail of the Return of the famous Comet
of 1682 in 1759, according to the Calculation and Prediction
of Dr. Halley. Compiled from the Observations of the most
eminent Astronomers of this Century.

R With Remarks and Reflections upon the
PRESENT COMET.

To which is prefixed, by way of Introduction,
A LETTER UPON COMETS.
ADDRESSED TO A LADY,
BY THE LATE M. DE MAUPERTUIS.
WRITTEN IN THE YEAR 1742.

L O N D O N :
PRINTED FOR T. BECKET, AND P. A. DE HONDT,
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TO THE RIGHT HONOURABLE
THE COUNTESS OF PEMBROKE.

M A D A M,

IN looking through the kingdom for a Lady to whom I might address the following sheets, no one could be found who seemed with such propriety entitled to them as your LADYSHIP.

The Great are so narrowly watched, that neither their virtues nor their vices, their perfections nor deficiencies, can long remain secret: and to say that your LADYSHIP is not only a lover, but a judge of astronomical subjects, is telling the public nothing new, since it was from the public I gained my information.

It is a power inherent in your LADYSHIP's family, to confer celebrity on works of genius. Even the great Sir Philip Sidney's name is lost in that of his Patroness,—his famous Romance being never mentioned by any other title than that of *The Countess of Pembroke's Arcadia*.

The Comet of 1759 is known throughout Europe by the name of Dr. Halley's Comet: Deign then, MADAM, to suffer the history of that Comet and the present one, to be honoured with your LADYSHIP's Name.

There

DEDICATION.

There is a shyness, or perhaps a pride, in English philosophers, which renders them superior to the common arts of acquiring fame, by means of retailing and explaining their discoveries; they are not more solicitous of arriving at those discoveries by the shortest road, than of relating them in the fewest words: and, by this means, our neighbours the French, are generally not only better acquainted with the labours of their own astronomers, but even with those of this nation, than ourselves.

I have, therefore, no pretensions, MADAM, in the following Essay, to any other merit than that of laying before your LADYSHIP and the public, the discoveries of men who disdain the task of doing it themselves.

This makes me hope that the presumption of an anonymous writer, (who only knows your LADYSHIP by the fame of your virtues and accomplishments) will be pardoned; as his most powerful motive for writing is the love of astronomy, and his highest ambition that of subscribing himself, with the most profound respect,

MADAM,

Your LADYSHIP's

Most humble,

And most devoted Servant,

The AUTHOR.

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SUMMARY ACCOUNT

OF THE LIFE OF

M. DE MAUPERTUIS.

PETER Louis Morceau de Maupertuis was born at St. Malo, the 28th of September, 1698, and was there privately educated till he arrived at his sixteenth year, when he was placed under the celebrated professor of philosophy M. le Blond, in the college of la Marche, at Paris. He soon discovered a passion for mathematical studies, and particularly for geometry. He likewise practised instrumental music in his early years with great success; but fixed on no profession till he was twenty, when he entered into the army. He first served in the grey musqueteers; but in the year 1720 his father purchased him a company of cavalry in the regiment of La Rocheguyon.

He remained but five years in the army, during which time he pursued his mathematical studies with great vigour; and it was soon remarked by M. Freret, and other academicians, that nothing

but geometry could satisfy his active soul, and unbounded thirst for knowledge. In the year 1723 he was received into the Royal Academy of Sciences, and read his first performance, which was a Memoir upon the Construction and Form of Musical Instruments, November 15, 1724.

During the first years of his admission he did not wholly confine his attention to mathematics; he dived into natural philosophy, and discovered great knowledge and dexterity in observations and experiments upon animals.

If the custom of travelling into remote climates, like the sages of antiquity, in order to be initiated into the learned mysteries of those times, had still subsisted, no one would have conformed to it with greater eagerness than M. de Maupertuis. His first gratification of this passion was to visit the country which had given birth to Newton; and during his residence at London he became as zealous an admirer and follower of that philosopher as any one of his own countrymen.

His next excursion was to Basil in Switzerland, where he formed a friendship with the famous John Bernouilli and his family, which continued to his death.

At his return to Paris, he applied himself to his favourite studies with greater zeal than ever,—and how well he fulfilled the duties of an academician, may be gathered by running over the Memoirs of the Academy, from the year 1724, to 1736; where it appears that he was neither idle, nor occupied by objects of small importance. The most sublime questions in geometry, and the relative sciences,

sciences, received from his hands that elegance, clearness and precision, so remarkable in all his writings.

In the year 1736 he was sent by the king of France to the polar circle, to measure a degree in order to ascertain the figure of the earth, accompanied by Messrs. Clairaut, Camus, le Monnier, l'Abbé Outhier and Celsius, the celebrated professor of astronomy at Upsal. This distinction rendered him so famous, that, at his return, he was admitted a member of almost every academy in Europe.

In the year 1740, he had an invitation from the king of Prussia to go to Berlin, which was too flattering to be refused. His rank among men of letters had not wholly effaced his love for his first profession, namely, that of arms. He followed his Prussian majesty into the field; and was a witness of the dispositions and operations that preceded the battle of Molwitz; but was deprived of the glory of being present, when victory declared in favour of his royal patron, by a singular kind of adventure. His horse, during the heat of the action, running away with him, he fell into the hands of the enemy, and was at first but roughly treated by the Austrian soldiers, to whom he could not make himself known, for want of language; but being carried prisoner to Vienna, he received such honours from their imperial majesties as were never effaced from his memory.

From Vienna he returned to Berlin; but as the reform of the academy which the king of Prussia then meditated, was not yet mature, he went again to Paris, where his affairs called him, and was

chosen, in 1742, director of the academy of sciences.

The Comet which appeared this year gave rise to the following letter: it was addressed to the celebrated marchioness du Chatelet, whose love for the sciences extended even to the study of mathematics: and she had M. de Maupertuis for her master in geometry, and the Newtonian philosophy.

In 1743 he was received into the French academy. This was the first instance of the same person being a member of both the academies at Paris, at the same time.

M. de Maupertuis again assumed the soldier at the siege of Fribourg, and was pitched upon, by marshal Cogny and the count d'Argenson, to carry the news to the French king of the surrender of that citadel.

He returned to Berlin in the year 1744, when a marriage was negociated and brought about by the good offices of the queen mother, between our author and mademoiselle de Borck, a lady of great beauty and merit, and nearly related to M. de Borck, at that time minister of state. This determined M. de Maupertuis to settle at Berlin, as he was extremely attached to his new spouse, and regarded this alliance as the most fortunate circumstance of his life.

In the year 1746 he was declared by his Prussian majesty, president of the royal academy of sciences at Berlin, and soon after by the same prince was honoured with the order of Merit.

However,

However, all these accumulated honours and advantages, so far from lessening his ardour for the sciences, seemed to furnish new allurements to labour and application. Not a day passed but he produced some new project or essay for the advancement of knowledge. Nor did he confine himself to mathematical studies only: metaphysics, chymistry, botany, polite literature, all shared his attention, and contributed to his fame.

But his constitution, though naturally robust, soon felt the effects of this intemperance, in his philosophical pursuits. Indeed his health had been considerably impaired before, by the great fatigues of various kinds in which his active mind had involved him. Though from the amazing hardships he had undergone in his northern expedition, most of his future bodily sufferings may be traced. The intense sharpness of the air could only be supported by means of strong liquors, which helped but to lacerate his lungs and bring on a spitting of blood, which began at least twelve years before he died.

Yet still after his bodily strength was thus impaired, his mind seemed to enjoy the greatest vigour, for the best of his writings were produced, and most sublime ideas developed, during the time of his confinement by sickness, when he was unable to occupy his presideal chair at the academy.

M. de Maupertuis took several journeys to St. Malo, during the last years of his life, for the recovery of his health. And though he always received benefit by breathing his native air, yet still, upon his return to Berlin, his disorder likewise returned with greater violence.—His last jour-

ney into France was undertaken in the year 1757, when he was obliged, soon after his arrival there, to quit his favourite retreat at St. Malo, on account of the danger and confusion which that town was thrown into, by the arrival of the English in its neighbourhood.

From thence he went to Bourdeaux, hoping there to meet with a neutral ship to carry him to Ham-
burgh, in his way back to Berlin; but, being disappointed in that hope, he went to Toulouse, where he remained seven months. He had then thoughts of going to Italy, in hopes a milder climate would restore him to health;—but finding himself grow worse, he rather inclined towards Germany, and went to Neufchatel, where for three months he enjoyed the conversation of lord Marshal, with whom he had formerly been much connected. At length he arrived at Basil, October 16, 1758, where he was received by his friend Bernoulli, and his family, with the utmost tenderness and affection. He at first found himself much better here, than he had been at Neufchatel; but this amendment was of short duration, for as the winter approached, his disorder returned, accompanied by new and more alarming symptoms.

He languished here many months, during which he was attended by M. de la Condamine, the oldest and dearest of his friends. But his fear of alarming madame de Maupertuis, and exposing her to the hazards and fatigues of a long journey, made him conceal his danger from her, though he ardently wished to see her. However, the truth of his situation, at length, reached her at Berlin, and she set out with the utmost precipitation, (for this
lady

lady was a pattern of conjugal affection, as well as of all other virtues,) but she was stopped on the road, by an express from Mess. Bernouilli and de la Condamine, with the melancholy news, that on July 27, 1759, death had put an end to his sufferings.

A

LETTER UPON COMETS.

Tu ne quæsieris, scire nefas.

YOU desire my opinion, madam, concerning the Comet which is at present the general topic of conversation throughout Paris; and your wishes are to me commands. But what can I say to you of this star? Shall I enquire into the influence it may have, or the events it may portend? A different star has decided the events of my life; and upon that my fate solely depends: To Comets, therefore, I abandon the fate of kings and empires.

It is not a century since astrology was in vogue both in court and city; astronomers, philosophers, and divines, agreed in thinking Comets the causes or forerunners of great events. Some few, indeed, rejected this species of divination by astrological rules; a modern author, celebrated for his piety and astronomical learning, believed this kind of curiosity more capable of offending an already incensed God, than of appeasing his indignation; and yet he could not refrain from giving us a list
of

of all the great events which comets have already preceded, or followed*.

These stars, after having been so long the terror of the world, are suddenly fallen into such disrepute, that they are no longer held capable of producing any thing but colds. It is not the present humour to believe, that bodies so remote as Comets can have any influence upon sublunary things; or can be meant as signs of what will happen in future. For what relation can there be between these stars, and what passes in the councils or armies of kings?

I shall not examine the metaphysical possibility of these things, either as to the influence, which neighbouring bodies reciprocally have upon each other, or that which the body has on the mind, of which, however, we cannot doubt, since on that frequently depends the happiness or misery of our lives.

But as to the influence of Comets, our knowledge must arise either from revelation, reason, or experience: and we may venture to say, that we have not yet found it in any one of these sources of our intelligence.

The existence of an universal connection between every part of nature is very certain, as well in the physical, as in the moral world: each event being connected with that which precedes, and to that which follows it, as a link of that chain which forms the order and succession of things: if it was not placed as it is, the chain would be different, and appertain to another universe.

* Riccioli Almagest. lib. viii. cap. 3 and 5.

Comets then undoubtedly constitute a part of the great chain of nature ; but the singing of birds, the swarming of bees, the minutest atom that floats in air, form likewise a part of this wonderful concatenation : and it would be equally reasonable to consult them, as Comets. In vain have we an idea of this scale of beings ; we draw no advantage from it to enable us to foresee events, when their dependencies are so remote : our safest rule is, therefore, to be content with discovering events, from those things only whose connection is more immediate and manifest.

We may compare astrologers to adepts, who are for ever labouring to draw gold from materials which only contain its principles and most trivial seeds ; they lose their time and labour, whilst the rational chymist enriches himself by extracting gold from earths and minerals, where it is already formed.

To endeavour at discovering the connections that subsist in nature, is no way inconsistent with prudence ; but it is downright folly to push these researches too far ; as it is the lot only of superior Beings to see the dependance of events, from one end to the other, of the chain which supports them. I shall therefore not entertain you with that kind of influence of Comets ; nor speak but of things within our conceptions, and for which we can give mathematical demonstration, or physical reasons. Neither shall I enter into a detail of all the strange ideas, which some have entertained concerning the origin, and nature of comets.

Kepler, to whom, in other particulars, astronomy has such great obligations, thought it but reasonable

reasonable, that as the sea has its whales and monsters, the air should have them likewise. These monsters are Comets: and he explained, how the excrement of the air engendered them *by an animal faculty*.

Some have believed that comets were created expressly when they were necessary to announce to man the designs of God; and that angels were their conductors. They added, that this explanation solved all the difficulties that could be raised on this point*.

In short, that all possible absurdities on this subject might be exhausted, there have been those who have denied the existence of Comets; and who have taken them for false appearances, occasioned by the reflection, or refraction of light. But they alone can comprehend how this reflection, or refraction could be made, without the existence of a body to occasion it†.

To Aristotle, Comets were meteors formed of sublunary exhalations; and this we may easily suppose, was the opinion of a herd of philosophers, who neither believed nor thought but in conformity to his doctrine.

Anterior to this, the ideas of Comets were more just. The Chaldeans, it is said, knew they were durable stars, and a kind of planets; and had even calculated their revolutions. Seneca embraced this opinion, and speaks of Comets in a manner so conformable to our present notion of them, that one might say, he predicted what experiment and mo-

* Mæstinus, Tannerus, Arriaga, &c. † Panætius.

dern observation have since ratified; for, after al-
 lowing them to be real planets, he adds, “ Ought
 “ we then to be surpris’d, if Comets, whose ap-
 “ pearances are so rare, seem not yet subjected to
 “ fixed laws; or that we are yet unable to deter-
 “ mine the course of stars, whose returns are not
 “ made till after such great intervals of time? It
 “ is not quite fifteen hundred years since the Greeks
 “ ascertained the number of stars and named them:
 “ many nations, at present, only know the heavens
 “ from what their eyes behold, and cannot account
 “ for the disappearance of the moon at certain pe-
 “ riods, nor what is the shadow that conceals her from
 “ us. It is but lately that we ourselves have had
 “ certain knowledge of these things; but the day
 “ will come, however, when time, and the dili-
 “ gence of posterity, shall disclose that of which
 “ we are now ignorant. One age is not sufficient
 “ to make such great discoveries, though our time
 “ were entirely devoted to them: what then have
 “ we to hope, who make such a miserable division
 “ of it, between study and vice *?”

I shall now, madam, proceed to explain to you
 what astronomy and geometry have taught us of
 Comets: and that which cannot be mathematically
 demonstrated, I will endeavour to supply by such
 conjectures as to me appear most probable. You
 will think, perhaps, after having for a long time
 paid too great respect to Comets, that we begin all
 at once to regard them with too much indif-
 ference.

To convey to you an idea of the importance of
 these stars, we must begin by saying, that they are

* Seneca, Natur. Quest. lib. 7.

not inferior in nature to planets, nor even to our earth. Their origin appears as ancient, their magnitude surpasses that of many planets, and the matter of which they are formed is of equal solidity ; and they even may, like the earth, have their inhabitants. In short, if the regular planets appear in some respects to have advantages over Comets, these have reciprocally advantages over planets. Now as Comets compose a part of the system of the world, I cannot make you perfectly understand them, without previously giving you a sketch of that system. But in order to facilitate your intelligence of it, I wish you had now before you Dr. Halley's chart of the solar system, with the explanation, in which the orbits, or paths of comets, are marked.

The sun is an immense globe of celestial fire, or of matter more like fire than any thing we know of ; but notwithstanding its prodigious size, it occupies a point only of that infinite space in which it is placed. We must not therefore call the point it occupies, either the centre, or extremity of this space, as that would imply a figure and boundaries. Each fixed star is also a sun which belongs to another system.

While our sun revolves on its own axis in the space of twenty-five days and a half, the matter of which it is composed flies off in all directions, extending in rays to a prodigious distance ; not only as far as our globe, but an immense way farther. This matter, of which light is formed, moves with such astonishing rapidity, that it employs but half a quarter of an hour in travelling from the sun to the earth. It is reflected back when it falls on bodies it cannot pierce ; and
it

it is by this light we perceive the opaque bodies of the planets, which reflect it back again to us ; for when the sun is hidden from us under the other hemisphere, it permits this feeble lustre to become perceptible.

There are six planets which have no light but that which they receive from the sun : these are Mercury, Venus, the Earth, (which cannot be denied a place among them) Mars, Jupiter, and Saturn. Each of them describes a great orbit round the sun, and as they are all placed at different distances, perform their revolutions round him in different times. Mercury, which is the nearest, finishes his course in three months : next to the orb of Mercury is that of Venus, whose revolution is completed in eight months ; then the orbit of the Earth, placed between those of Venus and Mars, is run through in one year, by the planet which we inhabit ; Mars employs two years to finish his course ; Jupiter twelve, and Saturn thirty. One remarkable circumstance in the revolutions which these stars make round the sun, is, that they are all performed the same way ; that is, apparently, from east to west ; which made a famous sect of philosophers * think, that the planets swam in a great vortex of fluid matter, which turning round the sun, carried them along with it, and was the cause of their motion.

But besides that the laws which govern the motion of planets, if well examined, is repugnant to such a vortex, you will presently perceive that the motion of Comets proves the utter impossibility of it. Many planets in performing their revolutions

* The Cartesians.

round the sun, turn at the same time on their own axis: perhaps they all have such a rotation; but we are not assured of any, except the earth, which does it in 24 hours; Mars in 25; Jupiter in 10; and Venus. But though all astronomers agree in allowing to this planet a revolution upon its own axis, of which they are assured by the diversity of faces she presents to us, they are not, however, yet agreed upon the time of this revolution: some say she performs it in 23 hours, and others in 24 days.

I have not mentioned the moon here, as she is not a planet of the first order; nor does she perform her revolution immediately round the sun, but round the earth, which at the same time carries her with her in the orbit she describes. Such planets as these are *secondary*, or *satellites*: and as the earth has one, so Jupiter has four, and Saturn five.

It is but lately that the laws by which the planets moved round the sun, have been discovered; and these laws of their motion, which were discovered by the happy Kepler, have assisted the great Newton to investigate their causes.

He has demonstrated, that as the planets move in the manner they do, round the sun, it is necessary that there should be a force which draws them continually towards this star; without which, instead of describing curve lines, as they do, each of them would describe right lines and become more and more distant from the sun, to infinity. He has discovered the proportion of that centripetal power which retains the planets in their orbits, and by this means has found the nature of those curves which this power will necessarily make them describe.

All

All these curves are reducible to conic sections; and observation shews us that all planets describe *ellipses* round the sun, which are oval curves formed by cutting a cone in a plane oblique to its axis.

It is demonstrated by geometry, that the sun cannot be in the centre of these ellipses; but towards one of their extremities, in a point which is called the *focus*: and this focus is so much nearer the extremity of the ellipse as it is the more excentric. The Sun's place is in this point: and from thence it happens, that, in certain times of their revolution, and in particular parts of their orbits, which are called their *perihelions*, the planets are found nearest the Sun; and that in others (when they are in their *aphelions*) they are most distant from it. Of the six planets we have mentioned, these different distances are not very considerable, because the ellipses they describe are not very excentric, deviating but little from circular figures. But the same law by which we observe them to form these ellipses, permitting them to describe ellipses of every degree of excentricity; the bounds, which nature seems to have prescribed to these orbits of the planets would be matter of astonishment, did we not find a greater diversity in those described by the new stars. Comets now fulfil what calculation foresaw, and what seemed deficient in nature. These new planets are always subject to the same law as the other six; but making use of the utmost liberty which this law permits, describe round the Sun ellipses very excentric, and of all degrees of elongation.

The Sun, placed in the focus common to every ellipses nearly circular, which the six planets describe, is likewise found in the focus of all the
other

other ellipses which Comets describe. The revolutions of these last round him are regulated by the same laws as the revolutions of the others: Their orbits once determined by observations, we can calculate their different places in the heavens for the rest of their course; and these places answer to those where we really find Comets, with the same exactness as planets answer to those places in the heavens, in which, according to calculation, they ought to be.

The only difference to be found between these new planets, and those first known, is, *imprimis*, that their orbits being much more excentric than those of regular planets, and the Sun, on this account, being nearer one of their extremities, the distances of Comets from the Sun, are much more various in the different parts of the orbits they describe. Some few (such as that of 1680) approach this star (the Sun) so nearly, that in their perihelion they are not a sixth part of his diameter distant from the Sun, and after this proximity they recede to immense distances, and to complete their courses, mount even beyond the regions of Saturn. From hence we may conclude, that if Comets are inhabited by living creatures, they must be of a temperament extremely different from ours, to enable them to support all these vicissitudes.

Secondly, Comets employ a much longer time than planets, in finishing their revolutions round the Sun. The slowest planet, Saturn, compleats his course in 30 years; while the swiftest Comet employs 75 years for his: and it is highly probable that the greatest number are many ages performing their courses. The length of their orbits, and the
C slowness

slowness of their revolutions, are reasons why we have not yet been able to ascertain the return of Comets positively; while planets never retire from those regions within reach of mortal view; Comets appear only during that little part of their course which they describe in the neighbourhood of the Earth: the rest is performed in the most distant regions of the heavens, during which time they are lost to us: and when a Comet returns, we have no knowledge of it, but from searching anterior records of Comets which have appeared after equal periods of time; and by comparing the path of that which appears, with the orbits of those, if we are furnished with sufficient observations of them for that purpose. It is by such methods that we are encouraged to think the period of the Comet which appeared in 1682 to be about 75 years; because we find a Comet which exhibited, in its motion, the same phenomena, did appear in 1607, in 1531, and in 1456. Now it is more than probable that all these Comets were the same; but of this we shall be more certain, if it appear again in 1757 or 1758*.

From similar reasons, but from an induction of less weight, Dr. Halley conjectures the Comets of 1661, and of 1532, to have been the same, taking 129 years to compleat its revolution round the Sun.

But Astronomers have advanced still farther in their researches concerning the Comet which appeared in 1680, and find such a number of appearances after equal intervals of time, that they very reasonably conclude its periodical revolution round the Sun to be 575 years.

* See the articles 1758 and 1759 in the following Essay.

But

But what prevents these conjectures from having the weight of certainty, is the want of precision in those observations which were made by the ancients. They applied themselves rather to the events which these stars portended, than accurately to observe their places in the heavens.

We cannot depend upon any observations on Comets anterior to Tycho Brahe: and till Newton came we had not the principles of the theory of these stars. Time only, and a sufficient number of observations can perfect this theory. Labour alone will be insufficient to attain that point of knowledge, at which mankind are permitted to arrive. It is a necessary lesson for them, and they may be well assured that neither incessant application, nor even the most sublime genius, can obtain it; they must wait till a certain epocha of time puts them in possession of it.

Although the astronomy of Comets is still far from perfect, and though we cannot yet minutely calculate their course, we ought to be, however, highly satisfied with the exactness which considerable parts of the path which Comets take, can be determined; and as they are subject to the same law which moves the other celestial bodies, as soon as the Comet appears, and has marked its orbit by some points in the heavens, where it has been observed, we determine its course by the theory, and the event has, to our wishes, answered the calculation, in all those Comets which have been carefully observed, as far, and as long, as our sight could follow them.

You will, perhaps, ask me, why then have we not the full extent of the orbits that Comets describe.

scribe, and the precise time of their return? It is not owing to any deficiency in the theory, but to the scarcity of observations, the imperfections of our instruments, and the debility of human sight.

The much extended ellipses that Comets describe, approach so nearly to parabolas, that in the part of their course where they are visible to us, there is not any perceptible difference. It is with these stars as with vessels, which we see set sail for long voyages: from their setting out, we can judge in general, towards what region of the earth they may be bound; but we cannot have a certain knowledge of what particular course they will steer, unless we could see them deviate from the track common to many countries *.

These parts of the course, which Comets describe, when in our view, are common to ellipses (which are curve lines returning into themselves) and to parabolas, which extend to infinity; in which case there is no hopes of a Comet's return: and we calculate their places, as if they really described these last mentioned curves; because the points where we find these Comets are sensibly the same, and their calculations are infinitely easier.

But if our sight could enable us to pursue Comets further, or if we could observe them with better instruments, we should see them abandon the para-

* i. e. Their deviation from the common course, if seen, would enable us to judge of the whole route. Thus Comets, during the short time they are visible to us, appear to move in a parabola; but could our sight extend far enough to enable us to see them deviate from that track (and turn inwards) we might then, from the information of our senses, conclude their course to be in an (extremely excentrical) ellipsis.

bolic

bolic route to follow the elliptic ; and be acquainted with the extent of their ellipses, and the return of the stars which describe them.

We cannot suspect the truth of this theory, if we examine the wonderful harmony, which is found in the observed courses of many Comets, and those calculated by Sir Isaac Newton *. I shall not therefore spin out this letter with the despicable systems, which different astronomers have forged on the motion of Comets : The opinions of those who supposed them meteors were not more ridiculous, and all their systems are as opposite to reason, as they are contradictory to experience.

The course of Comets once regulated, prevents our regarding them as supernatural presages, or as flambeaux lighted up to menace the earth. But while our superior knowledge of Comets, compared with that of the ancients, exempts us from these fears ; it informs us that they may be the physical cause of very extraordinary events.

Almost all the Comets of which we have the best observations, when they arrive in these regions of the heavens, have approached much nearer the Sun, than the earth ever does. They almost all cross the orbits of Saturn, Jupiter, Mars, and the Earth : and, according to the calculation of Dr. Halley, the Comet of 1680, passed so near the orb of the Earth, that on the 11th of November it was only half the Sun's diameter distant from it.

* See Tables of the Motions of several Comets, in his Principia, b. iii. prop. 41, and 42.

“ But, hitherto, none has threatened the earth
 “ with a nearer appulse than that of 1680; for by
 “ calculation I find that, Nov. 11, 1 h. 6. min. p. m.
 “ that Comet was not above the semidiameter of the
 “ Sun to the northward of the way of the Earth: at
 “ which time, had the earth been there, the Comet
 “ would have had a parallax equal to that of the
 “ Moon, as I take it. This is spoken to astronomers:
 “ but what might have been the consequences of
 “ so near an appulse, or of a contact, or lastly of
 “ a shock of the celestial bodies, (which is by no
 “ means impossible to come to pass) I leave to be
 “ discussed by the studious of physical mat-
 “ ters *.”

This great astronomer has calculated the orbits of 24 Comets, of which we were furnished with sufficient observations; and has found that these stars move in all directions; having nothing in common, but that their orbits are all described round the Sun.

A great sect of philosophers † held, that the celestial bodies of our system had no other motion than that of being carried away in a vast vortex of fluid matter round the Sun. Their opinion was founded upon this: that the motions of the planets are all in the same direction as that of the Sun, round its own axis. Though the fact is true in general, yet the planets do not so strictly follow this direction as they must do, if impelled by the general motion of vortices. They would then all move in the same plane, which would be that of the ecliptic, or at least in planes parallel to the ecliptic; but they do neither, which has greatly embarrassed these philosophers.

* Phil. Transf. N^o. 297. † Cartesians.

A great man * has attempted to account for this obliquity in the courses of planets, with respect to the plane of the ecliptic ; and we must admire the resources, and wonderful sagacity he has discovered, in defending the vortices against this objection. But Comets form an invincible obstacle to this vortex ; they not only deviate from the common road, but move freely in all directions : some following the order of the signs in a plane, very little inclined to the plane of the ecliptic : others in planes which are almost perpendicular to it : and some there are, whose motion is intirely retrograde, which move in an opposite direction to that of the planets, and of these pretended vortices ; which can only be done by these stars moving against an extremely rapid torrent, without suffering the least retardation. But those who believe this possible may make the experiment by rowing in a boat against the current of a river.

I know some astronomers have believed that the retrograde motion of Comets might not be such in fact, but in appearance ; and be in reality direct, as the motions of the planets are in some situations with respect to the earth. This might be credited, if we were permitted to dispose of Comets as we should judge convenient on this or that side the Sun ; and if, thus placed, they were capable of answering equally to the necessary laws of motion in the heavenly bodies. But this matter being well examined, and calculated, as it has been by Sir Isaac Newton and Dr. Halley, we find the impossibility of placing Comets just where partiality for vortices would require ; and we are reduced to the

* Mr. John Bernoulli, in his Dissertation concerning the Inclination of the Orbits of the Planets.

necessity of acknowledging them to be really retrograde. In this variety of motions, it is possible that a Comet may meet with a planet, in its course, nay, with our earth; and, if we should ever be so circumstanced, it is but natural to expect the arrival of some terrible accident. The mere approach of these bodies to each other would, no question, occasion great changes in their motions, whether by the attraction they would reciprocally exercise on each other, or by some fluid compressed between them. The least of these motions, must inevitably change the situation of the axis and poles of the Earth. That part of the globe which was formerly towards the equator, after such an accident, would be found near the poles; and that which was heretofore near the poles, we should find near the equator.

The approach of a Comet might produce consequences still more fatal; I have not yet mentioned their tails, which have been as productive of absurd notions, as any thing relative to Comets; but the most probable opinion is, that they are immense torrents of exhalations and vapours forced from them by the ardent heat of the Sun. The strongest proof of this is, that the tails of Comets are only visible when pretty near the Sun, that their size increases in proportion to their approximation to it, and decrease, and are dissipated, when they are distant from it.

A Comet accompanied by a tail, might pass so near the Earth, as to drown it in the torrent that it draws after it; or in an atmosphere of the same nature of that with which it is surrounded. The Comet of 1680, which was so near the Sun, sustained a heat 28,000 times greater than that of the Earth in
summer

summer, Sir Isaac Newton, in the various experiments he has made upon the heat of bodies, having calculated the degree of heat which this Comet must have acquired, found it would be 2,000 times hotter than red hot iron; and that a globe of red hot iron, of the size of the Earth, would be 50,000 years in cooling. What then must we think of the heat which yet remained in that Comet, when, returning from the Sun, it crossed the orbit of the Earth? Had it passed nearer, the Earth must have been reduced to ashes, or vitrified; or, if the tail only had reached us, the earth would have been drowned in liquid flame; in the same manner as we see a kingdom of ants perish by the boiling liquor which the labourer pours upon them.

An ingenious author has made some very singular and daring enquiries, concerning that Comet which was expected to burn the Earth*: tracing it back from 1680, (the time when it last appeared) he finds a Comet in 1106, another in 531 or 532, and one at the death of Julius Cæsar, forty-four years before our Saviour: this Comet is, with great probability, supposed to be the same, and performs its revolutions in 575 years; and the seventh period back from 1680, corresponds with the year of the universal *deluge*. After what has been said, we may easily conjecture in what manner the author may explain every circumstance of this great event. The Comet in its way to the Sun, passing near the Earth, drowned it with its tail and atmosphere, which had not then acquired the degree of heat which we have just mentioned, and caused the rain of forty days which is mentioned in the

* A new Theory of the Earth, by Whiston.

history of the deluge. But Whiston, from the approach of this Comet, drew still another consequence, which exactly agrees with the manner in which the divine writings have taught us to believe the deluge happened. The attraction which the Comet and Earth reciprocally exercise on each other, changed the figure of the latter; and drawing it towards the Comet, let out the subterraneous waters, by breaking open the fountains of the great abyfs. The same author has not only attempted in this manner to explain the deluge, but believes that, some time or other, a Comet, most probably the same, will, as it returns from the Sun, shed burning and mortal exhalations on us, and occasion to the inhabitants of the Earth all the misfortunes which are predicted to it, at the end of the world; and cause, in short, the *conflagration* which is to consume this unfortunate planet.

However bold his thoughts may be, they at least contain nothing contrary either to reason, revelation, or morality. God made use of the deluge to exterminate a race of men, whose crimes merited chastisement; and will probably, one day or other, in a still more terrible manner, destroy without exception all human kind: but he may have consigned the effects of his anger to physical causes; for He, who is the great Creator and Mover of each celestial body in the universe, may have regulated the courses of them all in such a manner, as to produce these great events in the fullness of time.

Though you should not be convinced, madam, that the deluge and conflagration of the earth depend upon the Comet, at least you will confess that its appulse may occasion some such accident. Gregory,

gory, one of the greatest astronomers of the age, has spoken in such a manner of Comets, as would re-establish them in all their former terrors. This great man, who has contributed so much to the perfecting the theory of these stars, in one of the corollaries of his excellent work, says, “ Hence, “ also it follows, that if the tail of a Comet should “ touch the atmosphere of our earth, (or if a part “ of this matter scattered and diffused about the “ heavens should fall into it) the exhalations of it “ mixed with our atmosphere, (one fluid with another) may cause very sensible changes in our air, “ especially in the animals and vegetables: for “ vapours, as they call them, brought from strange “ and distant regions, and excited by a very intense heat, may be very prejudicial to the inhabitants, or products of the earth; wherefore “ those things, which have been observed by all “ nations, and in all ages, to follow the apparitions of Comets, may happen: and it is a thing “ unworthy of a philosopher, to look upon them “ as false and ridiculous *.”

A Comet passing near the earth might so alter its motion, as even to change it into a Comet; and instead of continuing its present course, in an uniform mild climate of a temperature adapted to man, and the different animals which inhabit it, the earth would be exposed to the greatest vicissitudes, scorched in its perihelion, or frozen by the cold of the outermost regions of the heavens: proceeding thus from one evil to another, till perhaps another Comet again changes its course, and reinstates it in its original uniformity.

* Gregory, Astron. Physic. lib. v. corol. ii. prop. 4.

Another misfortune might still possibly befall the planet which we inhabit; for if a great Comet should advance too near the Earth, it might force it from its orbit, and oblige it to perform its future revolutions round the Comet; wholly subjecting it either by its attraction, or, if I dare use the word, by involving it in its vortex: the Earth thus become a satellite to the Comet, would be carried by it into those distant regions which it visits. Wretched condition for a free-born planet, which has so long enjoyed a temperate sky! In short, the Comet might in like manner rob us of our Moon; and were we to escape upon such easy terms, we might think ourselves very well off. But the most violent accident that could befall us, would be the percussive, or shock of a Comet against our globe, which might break both itself and the Earth into a thousand pieces. In such case, doubtless, both these bodies would be destroyed; and gravity would immediately form one or many planets out of them. If the Earth has never yet undergone these catastrophes, it has doubtless experienced many great changes. The prints of fishes, and even petrified fishes, which we find in places very distant from the sea, on the very summit of the highest mountains, are incontestable medals of some one of these events.

A less violent shock, such as would not entirely break our planet, would certainly cause great changes in the situation of lands and seas; the waters during such an accident would be greatly raised in some parts, and would drown vast regions of the surface of the earth, from which they would afterwards subside. To such a shock as this Dr. Halley attributes the deluge: the irregular disposition of the beds of different kinds of matter which

which composes the Earth; the enormous mountains, much more resembling the ruins of an ancient world, than one in its primitive state; all concur in giving weight to his opinion. This philosopher conjectures, that the excessive cold we find in the north-west parts of America, which is so little proportioned to the present latitude of those places, is the remains of cold in those countries which were formerly situated nearer the poles; and that the prodigious quantities of ice which we at present find there, is the remains of that by which they were formerly covered, and which is not yet entirely melted.

It is evident that, whatever may befall the earth, the other planets are equally liable to; unless the enormous size of Jupiter and Saturn should be their protection from the insults of Comets. It would be a very curious sight for us to behold a Comet approach, and fall upon Mars, Venus, or Mercury; and either break it into pieces in our view, or violently carry it away, in order to make it a satellite.

Comets may even attempt the sun himself; and though they have not sufficient power to draw him after them, yet their magnitude and near approach might enable them to remove him from his present place. But Newton secures us from such a removal, by a conjecture drawn from the known analogy between Comets and planets. Amongst these last, the least are situate nearest the Sun, and the greatest are most distant.

Newton conjectures that it is the same with Comets; that the least only approach very near this star, and the great ones are kept at the greatest distances;

distances *; lest, says he, they should disturb the Sun by their attraction. But is it necessary for the system, that the Sun should not be disturbed? Ought he alone to enjoy this prerogative? Or, rather, is it one? If we consider the celestial bodies as material masses only, is their immobility a perfection? Is not their motion, at least, as desirable as rest? Or should we regard them as capable of sentiment, is it unfortunate for me that another has the ascendancy? Is not the fate of him who is attracted as desirable as his who attracts?

You will allow, madam, that Comets are not so devoid of importance as they at present are generally believed. Every thing evinces them able to produce most destructive changes, both to our Earth, and to the whole solar system; from the dread of which habit only secures us. But after all, we have great reason to think ourselves safe from such calamities as these just mentioned; for the earth being but a point in the immensity of space, and our lives of so very transient duration, joined to our certain knowledge that in so many thousand years no accident of this kind has ever happened to the Earth; all these considerations are sufficient to prevent our apprehensions of being either witnesses, or victims, to any such in future. Thunder, however terrible, is but little to be feared by each individual, by reason of the small spot he engrosses in that space where the thunder may fall. It is the same with the little point we fill in the vast duration of time in which these important events happen. But though these considerations annihilate the danger to us, yet they cannot alter its nature.

* Philosoph. Nat. Princip. Mathemat. lib. iii. prop. 41.

But

But still the consideration that a common misfortune is scarcely any misfortune at all, ought to banish our fears; for the mortal who should unfortunately be of a constitution too robust, and who should solely survive the accident which had destroyed the whole human race, would have the greatest cause of complaint. King of the whole earth, possessor of all its treasures, he would languish with grief and sorrow; and his whole life would not be worth the last moment of him who expired with what he loved. But I fear I have railed too much at Comets; though I cannot reproach myself with injustice towards them, as they are really capable of occasioning every catastrophe to us that I have mentioned: however, I will make them all the reparation I can, by pointing out to you the advantages they may possibly procure us; though I very much doubt your being so sensibly touched by the hopes of these advantages, as alarmed by the fear of changing a state in which you have hitherto spent your time so agreeably. Our Earth has kept the situation it now holds in the heavens these five or six thousand years, during which time its seasons have been the same, and climates distributed as we now see, and with which we ought to be very well contented, without aspiring at a milder sky, or perpetual spring.

Nothing, however, would be more easy than for a Comet to procure us these felicities. Its approach, which, as we have shown, might cause so many disorders, might also render our condition much better. 1st. By occasioning a little change in the situation of the earth; it might elevate its axis, and fix our seasons to a continual spring. 2dly, A slight remove of the Earth in the orbit she describes round the Sun, would make her describe

describe one more circular, in which she would always be equi-distant from the star from which she receives both heat and light. And, 3dly, though it was observed above that a Comet might ravish our Moon from us, yet on the other hand, a small Comet might be reduced to a lunar state itself, and be both condemned to make its revolutions round us, and to illuminate our nights. It is very possible that our Moon was originally a little Comet, which advancing too near the Earth, was taken captive by it, and reduced to a state of servitude. Jupiter and Saturn, whose magnitudes are much greater than that of the Earth, and whose power extends further, and over larger Comets, can make such acquisitions with greater facility than the Earth : hence perhaps it is, that Jupiter has four moons to attend him, and Saturn five ; and though we have seen above how dangerous the shock of a Comet might prove, yet the mischief may be so inconsiderable, as to be fatal only to that part of the globe which receives the blow ; we might perhaps escape with the crush only of one kingdom, while the rest of the earth would enjoy those rare productions with which so great a traveller would present them. We should be greatly surprised, perhaps, to find the fragments of these so much despised masses composed of gold and diamonds : but it is hard to say whose amazement would be the greater, at our first meeting ; ours, or those inhabitants of the Comet which the shock might throw upon the earth ? What figures would each party think the other ?

But there is still another means of enriching ourselves from the spoils of Comets. In the discourse concerning the figure of the stars, it has been explained how a planet might appropriate to itself
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the tail of a Comet; and, without either drowning its inhabitants, or poisoning them by noisome vapours, might form it into a sort of ring or vault, suspended round it on every side. It has been shown, that the tail of a Comet might be so circumstanced, as that the laws of attraction would oblige it in this manner to surround the Earth: the form of these rings has been determined, and the whole answers so well to what is observed round Saturn, that it seems rather difficult for a more probable, or natural account of this phænomenon to be discovered; we must not therefore be astonished, if one day or other we should see a like appearance round the Earth.

Newton, in his reflections on the courses of Comets through all the regions of the heavens, and the prodigious quantity of vapours they drag after them, confers upon them an employment which is not perhaps the most honourable of any in the system: he supposes that they carry water and humidity to repair the losses of the other celestial bodies. Such a supply may perhaps be needful to the planets, but it would infallibly be fatal to their inhabitants, as these foreign fluids would differ too much from our own not to be noxious. They doubtless would infect both air and water; and the greatest number of inhabitants would perish. But nature often sacrifices small objects to the general good of the universe.

Another use of Comets may be, to repair the losses which the Sun sustains, by the continual emission of the matter of which it is formed. When a Comet passes so near it as to penetrate the very atmosphere which surrounds it, this atmosphere being an obstacle to its motion, and a check

to its velocity, must consequently alter the figure of its orbit, and contract the distance of its perihelion. And this distance constantly diminishing at each return of the Comet, it must, after a certain number of revolutions, fall into that immense fire (the Sun) to which it will serve for new aliment: for those vapours and atmospheres which would drown planets, are incapable of extinguishing the Sun.

What these Comets perform which move round our Sun, those may likewise perform which move round other suns, (the fixed stars) and may relumine stars which are nearly extinguished. But this is one of the least benefits we may derive from Comets: and now, madam, I have nearly communicated to you my whole cometary knowledge. A time will come, perhaps, when we shall all be wiser upon the subject: for Newton's Theory, which has enabled us to determine the orbit of Comets, will in time conduct us to the exact period of their revolutions.

But it will not be amiss to inform you, that although these stars, while they are visible to us, are governed by the same laws as the other planets, and are like them subject to calculation, yet we cannot be assured of seeing them return at the exact time assigned them, or in exactly the same orbits. The many accidents they may encounter in their way, such as passing by the atmosphere of the Sun, or meeting with planets, or other Comets, may so alter their courses, that after a few revolutions, we shall no longer be able to know them again.

I have spoken of almost every Comet, except that which appears at present; for this plain reason,

son, because I have but little to say about it. This Comet, which makes so much noise, is one of the most contemptible that ever appeared. Some have been seen whose apparent magnitude equalled that of the Sun; many whose diameters appeared a fourth or fifth part of his diameter. Others, again, have shone with various and vivid colours; some have appeared of a frightful red, many of a gold colour, and others enveloped in thick smoke; and some few have been said to have diffused a sulphurous smell even down to the very Earth. The greatest number drew tails of an enormous length after them; and the Comet of 1680 had one which filled near half the heavens.

This Comet appears only as a star of the third or fourth magnitude, and has a tail of between four and five degrees. It was discovered by Mr. Grant, the 2d of March, at the foot of Antinous.

If you wish for more science in this subject, with a succession of observations, made with the most finished accuracy, you will meet with them in that excellent work of M. le Monnier, called the Theory of Comets.

In the mean time, you will, I hope, be satisfied with knowing that this Comet has passed from Antinous into the Swan, and from the Swan into Cepheus, with such rapidity, that it sometimes ran six degrees in twenty-four hours. It proceeds towards the pole, and is not above ten degrees from it. But it abates of its speed; and its light and tail are so diminished, that we perceive it moves from the Earth; and that for this time, we have nothing either to hope, or to fear from it.

A N
E S S A Y
TOWARDS A HISTORY OF
THE PRINCIPAL COMETS
THAT HAVE
APPEARED SINCE THE YEAR 1742.

W A

Y A S S E

TOWARDS A HISTORY OF

THE PRINCIPAL COMETS

OF THE YEAR

APPEARED SINCE THE YEAR 1700

ADVERTISEMENT.

THE following Effay is intended for the use of such only as give mathematicians credit for their calculations of the orbits, or paths of Comets in the heavens; and who, (taking it for granted that those calculations are just) wish to gratify their curiosity, as well with regard to the result of mathematical demonstrations, as to the phænomena, and most interesting particulars of these erratick stars.

An astronomer, armed at all points with *Theorems, Problems, Corollaries, Lemmas, and Scholia*, is a very formidable being, and equally inaccessible to the generality of mankind, with the stars about which he writes. And yet, without these terrible arms to defend him from ignorance and presumption, his science would degenerate into judicial astrology, and he would be little better than a juggler or a fortune-teller. It is therefore intended in sketching out the following little history of Comets, to save the reader the expence of purchasing, and trouble of perusing a great number of difficult and dry treatises, and to give him the sum and substance of such discoveries and conclusions, as have proceeded from the most laborious and operose calculations, to which human intelligence can reach. And it should be remembered, that though the foregoing letter is written in a familiar and sportive stile, and accommodated to the perception of the ladies, and such as are unskilled in mathematicks, yet it is founded on true science: the author having been
among

among the first, and most able geometricians, who adopted and explained the Newtonian philosophy in France, and who, by his journey to the polar circle, in order to measure a degree, has proved and illustrated it, by ascertaining the figure of the earth to be just what our great countryman had always suggested it to be.

THE

T H E
H I S T O R Y
O F T H E
P R I N C I P A L C O M E T S

That have appeared since the Year 1742.

IN the preceding letter it has been remarked, that Dr. Halley upon the Newtonian theory, had determined the elements of twenty-four Comets*. At present the number of those that have been accurately observed, and whose orbits are calculated, is more than doubled. A particular detail of such as are most interesting may therefore be acceptable to our readers. We shall however, only just mention the Comets of 1702, 1706, and 1718, whose elements different astronomers have determined by the Newtonian method ; but shall be a little more particular about that of 1729. A Comet rendered very singular, if not by its brilliancy, at least by

* The elements of a Comet are the five articles which determine the position and magnitude of the parabola it describes, and which constitute its theory ; namely, its node, inclination, place of its perihelion, perihelion distance, which is the square of the parameter, and the time when the Comet arrives at its perihelion.

other circumstances. It was first perceived at Nismes, by father Sarabel, a Jesuit, July 31, between Canis Minor and the Dolphin, it was so small and dull, that during moon light, it was scarce visible; however, this father informed Cassini, and the academicians of it, who observed it from the 1st of August till the 21st of January 1730, when it disappeared. Their observations are published in the Memoirs of the Academy of Sciences for the year 1730, and after them Maraldi, in 1742, has calculated the parabolic trajectory, which it described. Many other astronomers have done the like, as the Abbé de la Caille, M. de Lisle, Mr. Kies, astronomer at Berlin, M. Struick, &c. It passed between the orbit of Mars and that of Jupiter, but much nearer the latter; hence it was always so small and moved so slow, (for it hardly advanced an eighteenth of a degree in the six months it was observed) at first its motion was direct, and then retrograde, like the superior planets. Calculation agreed so well with these observations, that though they amounted to fifty, the difference in longitude exceeds not three minutes, and in latitude only a few seconds.

We shall pass over the Comet of 1737 calculated in the Philosophical Transactions, N^o 446. That of 1739, of which several astronomers have given the elements; and come to that of

1742. This Comet, notwithstanding M. de Maupertuis thinks it so contemptible, was observed by Mr. Betts at Oxford, who supposed its magnitude to be, at least equal to that of the Earth.

1743. Two Comets appeared this year. The first was observed by M. Struick, the second by Mr. Klenkenberg;

Klenkenberg; but both were small and offered no remarkable phenomena to common observers.

1744. The Comet which appeared this year, was first seen in England, at the observatory of the Earl of Macclesfield, December 23, 1743. It seems to have been accurately observed at Oxford by the reverend Mr. Betts, who in his journal, January 23, 1744, says, "The Comet this evening appeared extremely bright and distinct, and the diameter of its nucleus, nearly equal to that of Jupiter, its tail extending above sixteen degrees from its body." and adds, "That on February 23 the prodigious brightness it acquired, by its near approach to the sun, made it visible in the day time." The nodes of this Comet, and the planet Mercury, were situated within less than half a degree of each other; which gave rise to a report that the Comet had carried Mercury from its orbit: but, says Mr. Betts, "Upon computing their heliocentric conjunction, which happened February 18, I found the Comet was, at that time, distant from Mercury nearly one third part of the great circle; being twice as near the Sun, as the planet Mercury. This was the most considerable Comet that had appeared since the year 1680.

M. des Chezeaux (*Essais de Physique* 1751) observes, that at its first appearance, it had no tail, at least perceptible to the naked eye; but in approaching the Sun, it acquired one which increased every day till it arrived at its perihelion; so that February the 17th it was forty degrees long, and it still augmented considerably after the perihelion; for though the body of the Comet could no longer be seen, the tail was visible two hours before

before sun-rise, 20 or 30 degrees above the horizon, while the body was below it. According to this author, the tail was divided into five large streams, or bands, and must have afforded a strange spectacle, if the Earth had been at that time in a favourable position for observing it. This Comet, and that of 1742, gave rise to several learned and ingenious works. Soon after M. de Maupertuis' letter, came out the Theory of Comets by M. le Monnier, 8vo. in which, besides the translation of Halley's Synopsis, is included an introduction and historical supplement concerning the progress of this theory, before and since Newton's time; together with divers interesting particulars relative to the catalogue of the fixed stars, and theory of the Sun: the treatise of M. des Chezeaux, mentioned above: *Offervazioni intorno la Cometa dell anno 1744*, or observations concerning the Comet of 1744 by Zannotti, professor at Bologna; and an excellent treatise by the celebrated Euler, called *Theoria Motuum Planetarum, & Cometarum*, or Theory of the motions of Planets and Comets, &c, &c.

1746. The Comet of this year was first observed at Lausanne, August 13, by M. des Chezeaux; and was seen afterwards by many other astronomers. It was then proceeding to its perihelion, to which it arrived not before February 8, 1747.

1748. M. Struyck informs us, (*Philosophical Transactions*) that in the month of May this year, three Comets were visible, both at Amsterdam, and in other parts of Europe, on the very same night; of which there is no other instance in history: one of them was observed by F. Hallerstein, at Pekin in China, from April 26, to June 18, who says (*Philosophical Transactions abridged*, vol. x.) "The
" Comet

“ Comet seen by us this year was very dismal, for
 “ besides its shining with a very obscure and ma-
 “ lignant light, it went in so desert a path, and in
 “ such an unfavourable sky, that it could be ob-
 “ served but very seldom, and be compared with
 “ but a few small stars not well known.”

1757. It is remarked by M. Montucla (History of Mathematics) that near ten years had elapsed since any Comet had appeared. A very uncommon circumstance, if we may judge by the frequency of these phenomena for some centuries past, since Comets have been so narrowly watched. The Comet of this year, however, came kindly to relieve our impatience. It was accurately observed by Dr. Bradley, from September 12, to October 11, and again on the 18th and 19th of the same month. “ When I first discovered this Comet (says the
 “ doctor, Philosophical Transactions, vol. L.) it ap-
 “ peared to the naked eye like a dull star of the
 “ fifth or sixth magnitude; but viewing it through
 “ a seven foot telescope, I could perceive a small
 “ nucleus, (surrounded, as usual, with a nebulous
 “ atmosphere) and a short tail, extending in a di-
 “ rection opposite the Sun.”

“ It kept nearly at the same distance from the
 “ the Earth for about ten or twelve days together,
 “ after I first saw it; but its brightness gradually
 “ increased then, because it was going nearer to
 “ the Sun. Afterwards, when its distance from the
 “ Earth increased, though it continued to approach
 “ the Sun, yet its lustre never much exceeded that
 “ of stars of the second magnitude; and the tail
 “ was scarce to be seen by the naked eye.”

The

The elements the doctor has given of this Comet (adapted to Dr. Halley's general table for the motion of Comets in parabolic orbits) will be sufficient to enable future astronomers to distinguish it upon another return; but as they do not correspond with the elements of the orbit of any other Comet hitherto taken notice of, we cannot at present determine its period.

This Comet was likewise observed by Mr. Klenkenberg at the Hague, who in a letter to Dr. Bradley says, "It appears very evident not only from
 " my calculation, but from every other circumstance of this Comet, that it is not the same with
 " that of the year 1682, which on certain accounts
 " is very desirable to be known; for both here,
 " and in other parts of the Netherlands, there have
 " been some people who have published mere conjectures; and have ventured (very minutely and
 " exactly, as they pretended) about the time that
 " this Comet first appeared, to predict the return
 " of that of 1682: but by the above observations
 " the weakness of their pretensions is evident;
 " whereas, if this had proved to be the expected
 " Comet, they would have assumed to themselves
 " much undue praise, and have pretended to know-
 " ledge even superior to the every-where much celebrated Newton, and Halley."

1758. Astronomers were much disappointed this year in not finding Dr. Halley's prediction fulfilled: who in his Synopsis of Comets has these words,
 " and indeed there are many things which make
 " me believe that the Comet which Appian observed in the year 1531, was the same with that
 " which Kepler and Longomontanus took notice
 " of and described in the year 1607, and which I
 " myself

“ myself have seen return and observed in 1682
 “ All the elements agree, and nothing seems to
 “ contradict this my opinion, besides the inequality
 “ of the periodic revolutions: which inequality is
 “ not so great neither, as that it may not be owing
 “ to physical causes. For the motion of Saturn is
 “ so disturbed by the rest of the planets, especially
 “ by Jupiter, that the periodic time of that planet
 “ is uncertain for some whole days together. How
 “ much more therefore will a Comet be subject to
 “ such like errors, which rises almost four times
 “ higher than Saturn, and whose velocity, though
 “ increased but very little, would be sufficient to
 “ change its orbit from an elliptical to a parabolic
 “ one. However, I am further confirmed in my
 “ opinion of the Comets which appeared at the
 “ above periods, being the same; and let me also
 “ add, that in the year 1456, in the summer time,
 “ a Comet was seen passing retrograde between the
 “ Earth and Sun, much after the same manner:
 “ which, though nobody made observations upon
 “ it, yet from its period, and the manner of its
 “ transit, I cannot think different from those I have
 “ just mentioned. Hence I dare venture to fore-
 “ tel that it will return again about the year
 “ 1758.”

As this is a point, and a period, of equally great
 importance in astronomy, we must not pass them
 over too hastily. Mr. Barker in a letter to Dr.
 Bradley, 1755 (inserted in the Philosophical Trans-
 actions of that year) has given, in twelve short
 tables, the apparent path of this Comet, supposing
 its perihelion any month in the year, with its ac-
 curate distance from the Earth. But as no allow-
 ance was made for the disturbance this Comet might
 have met with, either from the planets, or other
 Comets,

Comets, in its path, it did not return within the period for which his tables were constructed.

But while all the world was big with expectation, and astronomers had turned night into day, in hopes of the accomplishment of that prediction which was to confirm their favourite theory : while scoffers began to triumph in the hope that these star-gazers were no greater conjurors than themselves ; and while the friends to science began to tremble for the event : the profound and indefatigable M. Clairaut, one of the famous academicians who accompanied M. de Maupertuis in his voyage to the polar circle, remembering Dr. Halley had suggested that it was possible for the Comet of 1682 to be impeded or accelerated in its course, by its approximation to Jupiter, went to work in order to discover by calculation, its approaches, not only to Jupiter, but to the rest of the planets, and to find out their attractive powers over it. What a stupendous undertaking ! but let him speak for himself.

“ The return of the Comet of 1682, in the time
 “ prescribed by the Newtonian theory, (advertise-
 “ ment to his Theory of Comets, Par. 1760) is one
 “ of those events which diffuse new light upon the
 “ laws of nature, and which constitute a memorable
 “ æra in science. An event which has effectually
 “ dissipated the last remaining cloud which could
 “ possibly obscure the system of attraction.

“ In the year 1757, I had a mind to make a new
 “ application of the solution I had given of a fa-
 “ mous problem ten years before*, to demonstrate

* This was the problem of three bodies, first applied to the theory of the Moon. Vide Principia, lib. iii. prop. 25. prob. 6.

“ the

“ the universality of gravitation. The subject
 “ which afforded me this new application, was the
 “ Comet of 1682, which was then expected to
 “ return according to Halley’s prediction from
 “ Newton’s theory. As the action of the great
 “ planets upon this Comet might produce one or
 “ many years variation in its period, it rendered its
 “ return so uncertain that it was equally expected
 “ in 1757 or 1759*: I proposed therefore to find
 “ the true time when the expected Comet would
 “ reach its perihelion.”

* Though this has been asserted by Mr. Barker and many
 others, from the first edition of the Synopsis of Comets published
 in 1705; yet it is not exact. Dr. Halley then indeed foretels
 the return of this Comet in 1758. But many years afterwards,
 when he had carefully searched into the catalogues of ancient
 Comets, and discovered that three others in the same order, and
 at like intervals of time had preceded the three upon which his
 conjecture was founded, he began to be much more confirmed
 in his former opinion, of all these being one and the same
 Comet. But, after accounting for some small diversity in their
 inclinations and periods from the action of Jupiter, which, by
 its attraction, alters the proper velocity of the Comet when in
 its neighbourhood, the Doctor adds, “ it is probable that its
 “ return will not be till after the period of seventy-six years or
 “ more, about the end of the year 1758, or the beginning of
 “ the next. *Circa finem anni 1758, vel initium proximi futu-*
 “ *rum.*” This puts the year 1757 quite out of the question.

N. B. The above is taken from Dr. Halley’s *Tabulæ Astro-*
nomicæ, published in 1749, seven years after the author’s death,
 and ten years before the accomplishment of his prediction,
 which he finishes by these remarkable words. “ You see there-
 “ fore an agreement in all the elements of the three last ap-
 “ pearances, (in 1531, 1607, and 1682) which would be next
 “ to a miracle if they were three different Comets, or if it was
 “ not the approach of the same Comet towards the Sun and
 “ Earth, in three different revolutions round them. Wherefore,
 “ if, according to what we have already said, it should return
 “ again about the year 1758, candid posterity will not re-
 “ fuse to acknowledge that this was first discovered by an
 “ Englishman.”

“ The labour upon which I entered was im-
 “ mense, and I was unable to arrive at any certain
 “ conclusion before the Autumn of 1758. I then
 “ thought it behoved me not to lose a moment,
 “ ere I acquainted the public and astronomers,
 “ with the result of my operations.”

November 14, 1758, he presented to the Royal Academy of Sciences a memorial upon the subject and success of his enquiries. He there undertakes to prove, that the retardation of the expected Comet, so far from injuring, would confirm the system of attraction, as it was a necessary consequence of the extent of that power. “ This is a
 “ question which has not hitherto been examined
 “ by geometers: if it had, the result must
 “ always have been given conditionally. A body
 “ which passes into such remote regions, and re-
 “ mains out of sight during such long intervals,
 “ may be affected by causes wholly unknown to
 “ us; such as the action of other Comets, or
 “ even by planets, too distant from the Sun ever to
 “ be perceived by us.”

After this author had calculated all the disturbance that Jupiter might have occasioned to the Comet during its three entire revolutions, a new difficulty occurred: he found it necessary to go through the same operations with regard to Saturn; the mass of which planet being one third of that of Jupiter, might, *cæteris paribus*, produce one-third of its effect: and that was sufficient to merit a particular examination.

As to the other heavenly bodies in our system, their masses not amounting to the hundredth part of those of the two superior planets, their effect is almost insensible.

insensible.—He found that the action of Jupiter upon the Comet, during the whole revolution of 1531 to 1607, had occasioned a diminution of nineteen days in its period, which would not have happened by the mere force of the sun; and at the same time had altered its elements so as to produce an acceleration of near thirty one days in the following period.

“ Proceeding afterwards to the Revolution from
 “ 1607 to 1682. The action of Jupiter turns
 “ out much more considerable; for it occasions an
 “ acceleration of about 420 days, which added to
 “ the 31 resulting from the action of the same
 “ planet during the preceding period, amounts in
 “ all to 451 days of diminution in the time of its
 “ period; which would not have happen’d merely
 “ by its inclination to the sun.

“ Now if we take the difference of these two ac-
 “ celerations, in order to know how much shorter
 “ the second period was than the first, it appears
 “ to be 432 days; which differs only 37 days from
 “ the time resulting from the observations.

“ And this period appears to be still diminished
 “ by the action of Saturn. Indeed this diminution
 “ is not much, because the effects of Saturn’s
 “ force are almost reciprocally destroyed in the
 “ two first periods.”

“ Hence we see that the theory gives within a
 “ month, the difference so remarkable between the
 “ two known revolutions of this Comet. Now if
 “ we consider the length of these periods, the
 “ complication of the two causes of their irregu-
 “ larity, and the nature of the problem by which
 “ they

“ they are measured ; this new demonstration of
 “ the Newtonian system will perhaps be found as
 “ striking as any one that has hitherto been given.”

“ By comparing, in like manner, the force of
 “ the action of Jupiter, during the second period
 “ of the Comet, with that which will be termi-
 “ nated at its approaching return ; I find the re-
 “ volution about which we are at present interested
 “ will be 518 days longer than the preceding, oc-
 “ casioned by the action of Jupiter upon the Comet,
 “ from its last mean distance to its perihelion :
 “ that is, for the last seven or eight years ; an in-
 “ terval, during which there can hardly be more
 “ than fifteen days alteration.

“ As to Saturn, the result of its action on the
 “ Comet, is much more considerable compared
 “ with the two first revolutions ; for I find the
 “ present period protracted more than 100 days
 “ by it, independent likewise of its action since
 “ 1751, and another small object which I have
 “ not had time to determine. From these confi-
 “ derations, then, it appears to me that the ex-
 “ pected Comet ought to arrive at its perihelion,
 “ about the middle of the month of April next
 “ ensuing.”

This is a long quotation, but the subject of the memoir is curious, and the success of M. Clairaut, in determining so nearly a point of such importance to astronomy, and so interesting to all lovers of science, makes us as desirous to render it public, as to augment that fame to which he has so just a title.

But

But M. Messier, in an admirable memoir presented to our Royal Society in 1765, (of which an excellent translation by Dr. Matty is published in the transactions of that year,) has done justice to Mr. Clairaut. And as this memoir, consisting of thirty pages, contains a minute and satisfactory detail of the manner, in which the famous Comet in question was first discovered at Paris, by M. Messier, and afterwards observed by him and M. de L'isle; we shall make no apology to our readers for giving them a long extract from a performance so fraught with entertainment and instruction.

1759. “ In the predictions of the heavenly phenomena, which depend on the motion of the stars, two things are to be considered; viz. the time and place. As to the time, when the velocity, and direction of the stars in their motions, both apparent and real are known, the time of their different appulses and aspects may always be foretold; and the accuracy of the calculations depends on the exactness with which their velocity and their several inequalities are ascertained. Now it is well known, that all the former uncertainty as to the exact time of the return of the Comet foretold by Dr. Halley, was owing to the variations it must have undergone from its several situations, and approximations, to the planets, in its progress thro’ the solar system.

“ Dr Halley, who was first aware of the unequal returns of this Comet in its former appearances, which he found to have been alternately of 75 and 76 years, was likewise the first who assigned their true cause. He ascribed it, as I said above, to the nearer, or more distant ap-
 E 3 “ preaches

“ proaches of the planets of our system: and
 “ having observed, that the Comet we are speaking
 “ of, came very near Jupiter in the summer of
 “ 1681, above a year before its last appearance,
 “ and remained several months in the neighbour-
 “ hood of that planet, he judged that circum-
 “ stance alone sufficient to have considerably re-
 “ tarded its motion, and prolonged the duration
 “ of its revolution. Hence he concluded, that
 “ its return was not to be expected till the latter
 “ end of 1758, or the beginning of the next year.”

“ Dr. Halley observes, in confirmation of this
 “ opinion, that the action of Jupiter upon Saturn,
 “ is alone sufficient to alter the duration of Sa-
 “ turn’s period one whole month; and he adds,
 “ how much greater irregularities must not a Co-
 “ met be liable to, which, at its remotest distance,
 “ gets near four times farther from the Sun than
 “ Saturn; and whose velocity, in drawing near
 “ the Sun, needs but a very small increase to
 “ change its elliptic into a parabolic curve.”

“ Dr. Halley does not determine more exactly
 “ the time of the return of the Comet of 1682;
 “ neither could he do it, but by determining ex-
 “ actly the effect of the neighbourhood of Jupi-
 “ ter; which must very sensibly affect the velocity
 “ with which the Comet was moving towards the
 “ sun. Besides, regard must be had, not only to
 “ this approach to Jupiter in 1681, but likewise to
 “ the other approaches to this, and all the other
 “ planets, which act more or less upon the Comet,
 “ as they do upon each other. In short, it was
 “ necessary to consider all the different situations
 “ and distances of all the planets, with regard to the
 “ Comet, during the whole of its last revolution;
 “ and

“ and even during the former ones, when the re-
 “ turns had been found to be unequal.”

“ What immense labour! and what geometrical
 “ knowledge did this task not require? M. Clair-
 “ aut, of the Royal Academy of Sciences, un-
 “ dertook it; and his results differed but one
 “ month from the observation. No small degree
 “ of exactness this, considering the immensity of
 “ the object. In November 1758, he published
 “ his conclusion, which allowed about 618 days
 “ more for the period that was to end in 1759,
 “ than for the former; whence he inferred, that
 “ the Comet must be in its perihelion, towards
 “ the middle of April. He added however,
 “ (Journal des Scavans, Jan. 1759) Any one may
 “ think with what caution I venture upon this
 “ publication, since so many small quantities, un-
 “ avoidably neglected by the methods of approxi-
 “ mation, may very possibly make a month’s dif-
 “ ference, as in the calculation of former periods.
 “ It accordingly proved so, the Comet having
 “ reached its perihelion on the 13th of March in
 “ the morning. M. Clairaut has since published
 “ the methods and calculations, by which he has
 “ arrived at this conclusion.”

“ The impatience of astronomers, and their desire
 “ to prepare for verifying this prediction of Dr.
 “ Halley, had put them upon enquiring for feve-
 “ ral years, in what part of the Heavens this
 “ Comet was likely to appear; but being igno-
 “ rant of the exact time of its return, they could
 “ not determine the spot where it might be expect-
 “ ed to be seen, but by making various suppositi-
 “ ons as to the time of its perihelion. This Mr.
 “ Dirck of Klinkenberg, a famous astronomer in
 E 4 “ Holland,

“ Holland, had attempted seven or eight years
 “ before ; having taken the pains to calculate the
 “ principal points of fourteen different tracts,
 “ which the said Comet was to take, upon as many
 “ different suppositions relating to its passage thro’
 “ its perihelium, almost from month to month,
 “ from the 19th of June 1757, to the 15th of May
 “ 1758 ; Messrs. Pingré, and de la Lande, pro-
 “ ceeded much in the same manner in the calcula-
 “ tions they publish’d in the memoirs of Trevoux,
 “ for April 1759, first and second parts ; with this
 “ difference, that the latter in their suppositions
 “ had taken narrower limits, and nearer to M.
 “ Clairaut’s determination, who, as I said before,
 “ had fixed the return of this Comet to the mid-
 “ dle of April.”

“ M. de Lisle, being curious of seeing the Co-
 “ met on its first return, as soon as it could be
 “ discovered by means of refracting, or reflecting
 “ telescopes, before it was visible to the naked
 “ eye, thought he must proceed in a different
 “ manner from what other astronomers had done,
 “ to find out in what part of the heavens it must
 “ be looked for. He considered, that it was not
 “ necessary to know its place throughout its
 “ whole course, but only at the first moment of
 “ its appearance ; because, having once found it
 “ out, it would be an easy matter afterwards to
 “ trace it thro’ its whole progress by observation
 “ and calculation.”

“ A full description of this method, is to be
 “ found in an ample memoir concerning this Co-
 “ met, which I have laid before the Royal Aca-
 “ demy of Sciences, at Paris ; and which no doubt
 “ will be printed in their collection, together with
 “ a northern

“ a northern hemisphere, by means of which I
 “ have been enabled to look for this Comet, in
 “ the very place of the sky, where it ought to
 “ appear: and it was by the help of this planif-
 “ phere, that I actually discovered the Comet
 “ from the Marine Observatory at Paris, on the 21st
 “ of January in the evening, after searching for
 “ it two years successively, whenever the sky would
 “ permit. The weather was extremely clear the
 “ 21st of January the whole day and evening. I
 “ seized this opportunity, and as soon as the stars
 “ were visible after sun-set, I examined through a
 “ Newtonian telescope of four feet and an half,
 “ those places of the sky, where the planisphere
 “ shewed that the Comet was to be expected.”

“ After much pains, I perceiv’d about seven
 “ o’clock, a light resembling that of the Comet
 “ I had observed the year before in August, Sep-
 “ tember, October, and the beginning of Novem-
 “ ber *. I immediately made a configuration of
 “ this new light, with respect to the neighbouring
 “ stars, in order to examine the next night, whe-
 “ ther it had any motion among the fixed stars.
 “ This light appear’d pretty large, and in the
 “ middle I observed a nucleus, or bright spot,
 “ which was no proof as yet that it was a Comet,
 “ as there are some nebulous stars with a bright
 “ spot in the middle.”

“ January 22, at the same hour as the day be-
 “ fore, the sky being equally clear, I again saw
 “ the same light with a four feet and an half telef-
 “ cope, and found it had sensibly changed its
 “ place; but its appearances were the same. From

* See Mem. de l’Acad. Roy. des Scienc. Anno 1759.

“ this second observation I no longer doubted of
 “ its being a Comet.”

According to M. Messier, this Comet had three
 several appearances above the horizon, which M.
 de Lisle, and he calculated, as soon as they had
 made their first observations, that is as early as
 the month of February.

“ The first appearance of this Comet was in the
 “ evening, from January 21 to February 14,
 “ when I ceased seeing it, by reason of its en-
 “ trance into the rays of the sun. The second ap-
 “ pearance was at the Comet’s getting clear of the
 “ rays of the sun, in the morning, after the con-
 “ junction with that luminary, which was to take
 “ place a few days before its passage through the
 “ perihelion. I observed it in the morning from
 “ the 1st of April to the 17th, when it entered the
 “ rays of the sun a second time.” During this
 second appearance, the Comet was much larger,
 and brighter than in the middle of February;
 and indeed it was but 18 days past its perihelion.
 Now it is well known that Comets are much
 brighter after their perihelion, than at the same
 distance before it. “ Besides (says M. Messier) the
 “ Comet, after passing the perihelion, was as near
 “ again to the earth as on the 14th of February,
 “ when I lost sight of it at night. When I saw
 “ this Comet again on the 1st of April, I could
 “ very plainly discern its tail, but could not ascer-
 “ tain its length, because of the morning twilight,
 “ which was then beginning, and soon encreased
 “ much: it filled the field of the telescope; and
 “ must have extended far beyond: according to
 “ what I have observed the tail of the Comet must
 “ have spread to more than 25 degrees. the nu-
 “ cleus

“ nucleus was considerable, but not well terminated,
 “ and it apparently exceeded the size of stars of
 “ the first magnitude; it was of a pale whitish co-
 “ lour, not unlike that of Venus. The nebulosity
 “ which surrounded the nucleus, and went on less-
 “ ening, shewed reddish colours; and these co-
 “ lours grew more vivid, towards the brightest
 “ part of the tail. The morning twilight, which
 “ increased apace, soon put an end to these ap-
 “ pearances, and afterwards made the Comet itself
 “ disappear; however, I had been able to perceive
 “ it with the naked eye, when it was somewhat
 “ disengaged from the vapours of the horizon.”

“ The third appearance of the Comet was on the
 “ 29th of April in the evening, and I went on ob-
 “ serving it till the 3d of June at night, when I saw
 “ it no more.” During this last apparition, May 1,
 it appeared to the naked eye larger than stars of
 the first magnitude, the nucleus surrounded with
 a great coma. Its light was but faint, like that of
 the planets seen through the thick vapours of the
 horizon. It would have appeared brighter but for
 the light of the moon. In this last appearance of
 the Comet above the horizon, it was in the sex-
 tant, and was observed by most of the astronomers
 in Europe. The whole duration of its appearance
 was 134 days, reckoning from the 21st of January
 to June 3.

M. de la Lande's account of the return of this
 Comet, (prefixed to his edition of Dr. Halley's
 astronomical tables, published in 1759, just after
 the departure of the Comet) is very full, and
 satisfactory. We shall therefore present our rea-
 ders with such passages of that work as seem most
 interesting, first premising, that M. Clairaut con-
 fesses

feffes himself obliged to M. de la Lande for assisting him in his great work of calculating the disturbances incident to the Comet from its vicinity to Jupiter, &c. And M. de la Lande again, on his part, seems willing to participate this glory with Madame Lepaut, a lady who has long and successfully been employed in astronomical calculations, to whom he acknowledged himself indebted for help in the part he had undertaken.

“ The whole universe, says this author, has
“ been witness to the accomplishment of Dr.
“ Halley’s famous prediction, by the return of the
“ Comet of 1682, which descended to its perihelion
“ May 13, 1759, after a period of 27937
“ days, or 76 years and 6 months.”

“ A German pamphlet published at Leipfick last January, and many printed letters from Germany assure us, that it was seen by a peasant in the neighbourhood of Dresden, so soon as the 25th of December 1758. An astronomer of the same country also observed it soon after, of which he gave information to several of his friends *. And M. Messier discovered it at M. de Lifle’s, 21st of January (as related above.)”

* M. le Monnier (Mercure de France, Apr. 1759.) remarks, that not only this Comet had been seen first in Saxony, but the great one of 1680 had been seen there likewise two months before it was observed either in France or England. Occasioned, according to this eminent astronomer, by the land to the eastward of that electorate being sandy and dry. And as the east winds bring few clouds, they have there calm weather and a clear sky. “ It is to be wished, says M. le Monnier, that those
“ who inhabit climates where the sky is more serene than ours,
“ may have watched this Comet as narrowly as has hitherto
“ been done in France, to such it will be visible in the sextant, that is to say, a little below Leo, till the end of July.”

The

“The publick was much surpris'd at this Comet having no tail visible to the naked eye, though it always had one in its former appearances. But for this many reasons may be assigned. In the month of April, indeed, though the Comet was near the Sun, yet it was very far from the earth—from whence it could only be seen during the twilight. Now, it is well known, that not only the twilight, but even the light of the moon is sufficient to efface the tail of a Comet. Hence we should cease to wonder that no tail appeared in the month of April—let us see now what was its position in 1607 and in 1682, when the same Comet is said to have appeared with a remarkable tail. September 28th 1607, Longomontanus saw it with a very long and dense tail, which was 28 days before its perihelion; now supposing the earth's distance from the sun to be as 10, the Comet was then only 2 of those parts distant from the earth, and $8\frac{1}{2}$ from the sun. August 29, 1682, M. Picard saw the Comet with a tail 30 degrees long; Hevelius allowed it only 16 degrees; but this was 16 days before its perihelion; it was then distant from us $3\frac{1}{2}$ 10^{ths} and from the sun $6\frac{1}{2}$.”

“Hence, in both cases, there is a more favourable combination in its distance, both from the sun and the earth, than when it last appeared, which is sufficient to explain the different figure it made. We should then treat with all due contempt every suspicion of this Comet not being the same as that of 1682: its inclination, perihelion, nodes, distance from the sun, motion *, and even its late

* All these may be seen and compared by any one who will take the trouble to inform himself of the meaning of these terms, and to cast his eye over the following table, constructed by the the Abbé de la Caille. *Leçons d'Astronomie* 1761.

TABLE

T A B L E

O F T H E

Elements of the several Revolutions of HALLEY's Comet.

Year of Appearance.	Place of the Ascending Node.		Inclination of the Orbit.		Place of Perihelion.		Log. of the Perihelion Distance.	Passage thro' the Periheli- on, mean time at Paris.		Motion.	Orbit by whom Calculated.	
	S.	D.	M.	S.	S.	D.		M.	D.			H.
1456	I	18	30	0	17	56	0	10	1	0	0	Pingré.
1531	I	19	25	0	17	56	0	10	1	39	0	Halley.
1607	I	20	21	0	17	2	0	10	2	16	0	Halley.
1682	I	20	48	0	17	42	0	10	1	36	0	Halley.
1759	I	23	49	0	17	39	0	10	3	16	0	La Caille.
								June	8	22	10	Retrograde
								August	24	21	27	Retr.
								October	26	3	59	Retr.
								Septem.	14	21	31	Retr.
								March	12	13	41	Retr.

arrival occasioned by the attractions of Jupiter and Saturn, which so well agree with calculation; all these circumstances amount to so full and striking a demonstration, that I am ashamed to stop a moment at such difficulties. However, as the academy always publishes the result of its labours; and as doubts, however groundless, always occasion a suspension in the progress of the human mind, I thought I should be excused by men of science if I tried to remove objections which, perhaps, with some may gain credit, however ill founded."

The most important objection, as to the return of this Comet, arises from the inequality of its periods, which were as follows: that from August 25, 1531, to the 26th of October 1607, was performed in 76 years, and two months; that from October 26, 1607, to September 14, 1682, was rather less than 75 years; and its last period from the 14th of September 1682, to the 13th of March 1759, which was the longest of all, was 76 years and six months; or 27,937 days, amounting to 583 days more than in the preceding period.

Dr. Halley was aware of these differences, and at first confessed himself to be a little stagger'd by them, nor would he have had the courage to pronounce its return so positively, if history had not informed him, that Comets had appeared in 1456, 1380 and 1305, which put their identity out of all doubt.

These appearances happening alternately in seventy-five and seventy-six years, and as the preceding period was only of seventy-five years, it was natural to suppose that the next would amount to
seventy-

seventy-six. But as the difficulties arising from these inequalities in the periods have been foreseen and obviated by Dr. Halley, we cannot do better than to insert his own words.

“ Perhaps some may object to the diversity of
 “ their inclinations and periods, which is greater
 “ than what is observed in the revolutions of
 “ the same planet; seeing one period exceeded
 “ the other by more than the space of one year,
 “ and the inclination of the Comet of the year
 “ 1682, exceeded that of the year 1607, by
 “ twenty-two entire minutes. But let it be con-
 “ sidered what I mentioned at the end of the tables
 “ of Saturn, where it was proved that one period
 “ of that planet is sometimes longer than another
 “ by thirteen days; and that is evidently occasioned
 “ by the force of gravity tending towards the centre
 “ of Jupiter, which force indeed in equal distances
 “ is only the thousandth part of that force tending
 “ to the Sun itself, by which the planets are re-
 “ tained in their orbits. But by a more accurate
 “ computation, the force of Jupiter towards Sa-
 “ turn, for example, in the great conjunction as
 “ they call it, January 26, in the year 1683, was
 “ found to be to the force of the Sun upon the same
 “ Saturn, as 1 to 186; the sum of the forces there-
 “ fore is to the force of the Sun, as 187 to 186.
 “ But at the same distance from the center, the
 “ periodic times of bodies revolving in a circle are
 “ in the subduplicate ratio of the forces with which
 “ they are urged: wherefore the gravity being
 “ increased by 186th part of itself, the periodic time
 “ will be shortened by about the 374th part, that
 “ is by a whole month in Saturn. How much
 “ more is a Comet liable to these errors, which
 “ makes its excursion near four times higher than
 “ Saturn;

“ Saturn; and whose velocity being increased by
 “ less than the 120th part of itself, would change
 “ its elliptic orbit into a parabolic trajectory.”

“ But it happened in the summer of 1681, that
 “ the Comet seen in the following year, in its de-
 “ scent towards the Sun, was in conjunction with
 “ Jupiter in such a manner, and for several months
 “ so near him, that during all that time it must
 “ have been urged likewise towards the centre of
 “ Jupiter with near the 50th part of that force by
 “ which it tended towards the Sun: whence, ac-
 “ cording to the theory of gravity, the arc of the
 “ elliptic orbit, which it would have described had
 “ Jupiter been absent, must be bent inwards to-
 “ wards Jupiter in an hyperbolic form winding, and
 “ have assumed a kind of curve very compounded
 “ and as hitherto not to be managed by the
 “ geometers; in which the velocity and direction
 “ of the moving body, in proportion to the cause,
 “ would be very different from what it otherwise
 “ had been in the ellipses.”

“ Hence a reason may be assigned for the change
 “ of its inclination: for as the Comet in this part of
 “ its path had Jupiter on the north almost in a per-
 “ pendicular direction to its path, that portion of its
 “ orbit must be bent towards that quarter; and
 “ therefore its tangent being inclined to a greater
 “ angle towards the plane of the ecliptic, the angle
 “ of the inclination of the plane itself must be ne-
 “ cessarily increased. Besides the Comet continu-
 “ ing long in the neighbourhood of Jupiter, after
 “ it had come towards him from parts much more
 “ remote from the Sun with a slower motion, and
 “ now being urged with the joint central forces of
 “ both, must have acquired more accelerated velo-

“ city, than it could lose in its recess from Jupiter,
 “ by forces actng a contrary way, its motion being
 “ more swift, and the time being less.” (*Tabula
 Astronomica.*)

When the Comet of 1682 descended towards the Sun and became visible, Europe had scarce recovered from the terrible panick into which it had been thrown but eighteen months before by the great Comet. However, this was comparatively too inconsiderable to be much regarded, for it was little imagined then, that the least of the two would become the most interesting, and that it would be for ever celebrated by posterity for having taught mankind how to know all the rest. But however inferior to the other this Comet may have appeared in vulgar eyes, astronomers observed it with the greatest attention. Hevelius at Dantzick, Kirch at Leipzig, Flamsteed and Halley in England, Zimmermann at Nuremburg, Baert at Toulon, Montanori at Padua, and Picard, Cassini and la Hire at Paris. This list of names will suffice to shew that there can be no scarcity of good observations upon this Comet during that appearance.

In 1607 it was observed by the famous Kepler, who published his observations together with his general theory (*de Cometis Libelli 3, autore Joanne Keplero, augustæ vindelicorum 1619.*) The 16th of September old stile, the sky being very clear, Kepler first saw this Comet upon the bridge at Prague, and though it had no tail when he first discovered it, yet afterwards it had one of a considerable length and splendor. It was likewise observed by Longomontanus, September 18, (*Astron. Danicæ appendix Amst. 1640.*) he says it appeared as large as Jupiter, though with a very obscure and pale light; that the
 tail

tail was pretty long and more dense than the tails of Comets usually are, but as pale in colour as the Comet itself.

In the preceding revolution of 1531, we find our Comet observed by the astronomer Appian at Ingoldstadt, the same who first remarked that the tails of Comets were always in an opposite direction to the Sun: which to him was an evident proof that the Sun was the cause of such eruptions.

In 1456, there was a very remarkable exhibition of the same Comet. *Cometa in auditæ magnitudinis toto mense Junii cum prælonga Cauda, ita ut duo fere signa cæli comprehenderit. (Theatrum Comet:)*

It is difficult to comprehend how the Comet whose tail was so inconsiderable in its last appearance, should in this have one of sixty degrees: but M. de la Lande in his Theory of Comets, p. 127. accounts for this difference in the following manner. “ I find, says this active astronomer, that
 “ if the Comet reached its perihelion in the beginning of June, it ought to have appeared at night
 “ towards the middle of the month with sixty degrees of elongation and a very northern latitude,
 “ its distance from the Earth being less than the
 “ semidiameter of the Sun: so that in this position,
 “ which of all others is the most favourable, it
 “ must have appeared in all the splendor allowed
 “ to it by the old chronicles. Perhaps by *duo*
 “ *signa*, they only mean the extent of two constellations, which is often much less than two signs
 “ of the ecliptic.”

In 1379 and 1380 we find two Comets mentioned by Alstedius and Lubienietzki, but without any particulars as to the time or form of their appearance.

In 1305, our Comet again appears, according to the historians of that time, in all its terrors. *Cometa horrendæ magnitudinis visus est circa ferias paschatis, quem secuta est pestilentia maxima*, it is very likely that the horror occasioned by the plague had augmented the terrible impression left by the Comet; however, upon calculation, it does appear that the Comet must this year have passed very near the Earth.

The history of this Comet might be traced much higher by consulting Eckstormius, Riccioli, Alstedius, and Lubienietzki. Among the four hundred and fifteen Comets mentioned by this last writer, we find one for the year 1230, which appears to be the very Comet in question; another in 1005, three periods before; it is found in 930, and higher up in the year 550, marked by the taking of Rome by Totila. All the historians of the empire speak of a great Comet in the year 399, which may have been the same. *Cometa fuit prodigiosæ magnitudinis, horribilis aspectu, comam ad terram usque demittere visus.*

In 323, that is to say, seventy-six years before, a Comet also appeared in Virgo; and in short it would be easy to mount, without quitting the same periods, as high as 130 years before Christ, when, according to Justin, one appeared at the birth of Mithridates. But, in these early periods, there would be great danger of meeting with some of those fabulous Comets with which it was thought necessary perhaps

perhaps to embellish every famous reign: and it must be confessed too, that equal intervals between the different apparitions of Comets, are not alone sufficient to prove their identity: such equalities may indeed contribute towards the support of a demonstration founded on an agreement in their motions, and a perfect correspondence in the other circumstances of their appearance, but greater stress must not be laid upon them: for these compilations were not formed with the same care and exactness, which would have been bestowed upon them, if, when they were made, it had been suspected what advantages were to be derived from them. Lubienietzki seems to have had no other view than to compare the events subsequent to the appearance of Comets, in order to prove that they have presaged *nothing*: just as his predecessors, among whom was the good father Riccioli, had compiled them in order to prove them to be *inauspicious augurs*.

Riccioli, in his *Almagest*. published in 1651, enumerates 154 Comets to be found upon record in history, the last of which appeared in 1618. But in the great work of Lubienietzki*, (a Polish gentleman descended from the Sobieski family, but who being tainted by Jecinianism was forced to quit his country,) where not a single historical circumstance relative to Comets is omitted, the number in 1665 amounted to 415. “ Since that time, says M. de
“ la Lande, in 1764 (*Astronomie*, 2 vols. 4to)
“ they are increased to 450. But of all these ap-
“ pearances, no Comet had its path astronomically
“ described till 1264†, and the number of those
“ which have been observed, with sufficient accu-

* *Theatrum Cometicum*, Amst. 1668.

† *Tractatus Fratris Egidii de Cometis*.

“ racy to determine their orbits, is reduced to fifty
 “ one, exclusive of the Comet of 1531, 1607,
 “ 1682 and 1759 which is allowed to be only dif-
 “ ferent returns of one and the same Comet.”

It should be remembered that though every meteor and strange appearance in the heavens was by the ancients called a Comet, and that many of those which were intitled to that appellation, were the same Comets seen at different revolutions ; yet it may easily be supposed, that in every age, and especially in the early ones, many Comets have appeared concerning which historians have been silent, as well as many others, which on account of their distance, or of cloudy skies, have not been visible to the inhabitants of the globe.

We must not wonder then, if among the 415 Comets mentioned by Lubienietzki, there are near 400 from which nothing positive can be concluded. But whatever uncertainty there may be in these remote periods, we have four returns of one Comet perfectly well ascertained, which joined to that of 1759, put the theory of this Comet out of the reach of cavil, and constitute the greatest triumph of astronomy and the highest glory of the human mind.

Dr. Bevis observed this Comet in London, May 1 and 2, and exultingly says (Phil. Transf. vol. 51.)
 “ I think I may now venture to pronounce this to
 “ be the same as the Comet of 1682 ; and am
 “ about making out its future track. If I presume
 “ rightly, it will in a short time become in a man-
 “ ner stationary, but diminish very fast both in size
 “ and light, the Earth and it receding from each
 “ other almost in a right line. It is at this
 “ time

“ time about four times nearer the Earth than the
“ Sun is.”

Mr. Munckley likewise observed it at Hampstead, April 30, May 1, 2, 5, and 6. “ It is a luminous
“ appearance, says he, very evident to the naked
“ eye (notwithstanding the light of the Moon,
“ within two or three days of her quadrature) yet
“ rather dim than splendid, large, but very ill de-
“ fined, &c.”

We cannot quit this article without mentioning, that though the period of this Comet is the shortest of any yet discovered, (Dr. Halley calls it the Mercury of Comets) its aphelion, or greatest distance from the Sun, is thirty-five times greater than that of the Earth, and four times greater than that of Saturn, the most remote of any of the planets.

Indeed this Comet, so big with consequences, seems, it must be allowed, very diminutive as to size, compared with many others: however, no one point in astronomy ever engaged the attention of so many great astronomers as the return of this Comet. Newton, Halley, Maupertuis, Clairaut, de Lisle, le Monnier, la Caille, Messier, la Lande, Pingré, &c. have been indefatigable in observing and calculating its course. There was a controversy among the French astronomers, concerning the methods of finding it, and the exact time of its perihelion; but they and all the astronomers in Europe were unanimous in pronouncing it to be the same Comet which appeared in 1682; and here we cannot help repeating, for the honour of astronomy and of the English nation, that this Comet was first calculated, and its return predicted by the great Dr. Halley, in

confirmation of the theory of the illustrious Sir Isaac Newton.

1760. The Comet of this year was discovered, in the constellation Orion, at Cambridge, by Dr. Mason, and at Paris by M. Messier, on the same night, and at the same hour: namely, January 8, about nine o'clock in the evening. January 9, the late Mr. Short, Mr. Munckley of Lincoln's-Inn, and Mr. Day at Lowick, Northamptonshire, severally observed it. They all speak of the extream rapidity of its motion, and of the body being ill defined; but of the tail, those who saw it in England, say nothing, except Mr. Short, who, after remarking that its motion was to the westward with a considerable velocity, seemingly about two degrees in a day, which was nearly at the rate the great Comet moved, when it was first seen in the end of the year 1743, adds, " This Comet is very visible to the naked
 " eye, though I could perceive nothing of a tail,
 " and therefore I conclude it is going down to the
 " Sun." But the account of this Comet in the *Mercure de France*, of January 1760, says, the tail has an eastern direction, and is about four degrees long, but scarcely visible to the naked eye. The late Dr. Stukely seems to have thought this Comet was the same as that of 1664. But Mr. Barker (Phil. Tran. vol. 52.) rather discourages that opinion. " The Comet of 1664, says he, might have
 " appeared nearly in the same place this was
 " seen, with a swift motion of a pretty many
 " degrees in a day, as a retrograde Comet in op-
 " position to the Sun generally has; but, I think,
 " would not have been near enough to have moved
 " a degree in an hour, as this did; and I think it
 " would have been also a larger and continued
 " longer than this; for in 1664, it was seen four
 " months,

“ months, and when far distant from the earth;
 “ and in the position it must have been in last
 “ January, would hardly have gone farther back
 “ than the beginning of Gemini, in small north
 “ latitude, and is, I believe, one of the largest
 “ Comets.”

But M. Messier, who first discovered in France the three last mentioned Comets, seems to have found this year a fourth Comet, concerning which he communicated his observations to the Royal Academy of Sciences. This Comet, wholly different from that of which we have been speaking above, was first seen by M. Messier, January 26, at which time it could be perceived only through a foot reflecter, though soon after, with great difficulty, by the naked eye. Its nucleus appeared pretty clear, and well defined, through a $4\frac{1}{2}$ foot Newtonian telescope. The day of its discovery it was situated between the constellations *Crater* and *Hydra*. February 4, it was visible in *Leo*: and on the eighth appeared to the naked eye equal to a star of the third or fourth magnitude, and was very brilliant, having a tail (visible indeed only through a telescope) of many degrees in length, with a western direction.

1762. The Comet which appeared this year, is supposed by Mr. Struick and M. Pingré, who both observed it, and compared their observations with those of other astronomers, to be the same with that which appeared 169 years before, viz. in 1593. Its course was direct, and it arrived at its perihelion, May 28. In constructing the elements of this Comet, a remarkable singularity occurred to M. Pingré: he found that it had passed eleven times nearer the Sun than the Earth does
 when

when it is in its perihelion; and likewise, that though it was seen a very few days after its perihelion, and might be expected to have equalled the celebrated Comet of 1680 in splendor, yet it did not exceed in brightness a star of the third magnitude, its tail at the same time not extending above four degrees. M. Pingré therefore supposes it to have been very small, and that its atmosphere was not qualified to absorb or attract, according to M. Mairan's ingenious system, a sufficient quantity of those luminous particles, which says M. Mairan, compose the solar atmosphere*.

1764. Another Comet is this year discovered, in the constellation of the Dragon, by M. Messier, at the Marine Observatory at Paris; of which he has sent a table of the places to our Royal Society, from January 3, to February 11, together with the elements of the theory of this Comet, deduced from the first observations of M. Messier by M. Pingré. This Comet passed by the perihelion, February 12, with a retrograde motion.

1766. Two Comets are this year discovered by the vigilant and perspicacious M. Messier. These stars by being so numerous, will soon cease to be regarded with the same wonder as formerly; however, it must be owned, that the frequency of these discoveries is in a great measure owing to the use and improvement of telescopes; without which, we should know no more of many that have lately been seen, than our short-sighted forefathers did of the satellites of Jupiter and Saturn. As to M.

* This article is extracted from the Hist. de l'Acad. des Sciences, for the year 1763, in which volume M. Bailly gives several observations on the same Comet.

Messier,

Messier, he is so constantly on the look out, and so dextrous in discovering them, that it would incline one to believe with Cassini, that there was really a zodiac of Comets, and that M. Messier alone knew its place and limits in the heavens.

The first Comet of this year was discovered at the Marine Observatory at Paris, March the 8th, in the constellation of *Pisces*, and observed till the 15th of the same month; its motion was retrograde, and it seem'd in size, equal to a star of the fourth magnitude.

The second Comet was at first discovered with the naked eye, April the 8th, near the *Pleiades*, and promised to become considerable. The next day the tail was six or seven degrees long, and the nucleus equally luminous with stars of the third magnitude. It was however visible only till the 12th. M. Messier sent tables of the places of these Comets to the Royal Society this year, together with a calculation of the elements of their orbits by M. Pingré.

The second of these two Comets was discovered at Louisburg, in the island of Cape Breton, April the 7th, which was one day sooner than even M. Messier had seen it at Paris. In this observation, made by Captain Holland, the tail of the Comet appeared perpendicular to the horizon, with its head towards the sun.

Mr. Brice observed the same Comet at Kirknewton, April the 10th. It was then descending towards the sun, at the rate of about six degrees in the space of twenty-four hours. To this gentleman's

man's account, in the Philosophical Transactions, is prefixed a plate of the appearance of the Comet.

1769. The first intelligence we had of this Comet in England, was from the indefatigable M. Messier, astronomer, keeper of the journals, plans and maps belonging to the marine of France, who discovered it the 8th of August, about 11 in the evening, in the constellation Aries, between the 24th 25th and 31st stars of that constellation in the British catalogue. On the 14th and 15th of the same month it appeared very distinctly, having a tail about six degrees in length. This information was inserted in the St. James's Chronicle, August 25, which set us all to work in order to find it here. Not many days had elapsed, ere it was seen by all who were possess'd of telescopes, and in the beginning of September, it was visible to the naked eye, about three o'clock in the morning, in the constellation of Taurus, with a tail fifteen degrees long. The body of this Comet became more considerable to our view, till the middle of September, when the tail was of an enormous breadth, and extended to upwards of 40 degrees in length.

The publick is, doubtless, much obliged to Mr. Dunn, for his observations, which appeared so frequently in the news-papers, though he put them in a great fright for our beautiful morning and evening star, the planet Venus, which, "he thought
"likely to receive a *brush* from the Comet's tail." However, he did not suffer their anxiety to continue long, but ventured two or three days after to pronounce Venus out of danger.—But may we not suppose that the whole solar system, that is to say, our sun—with its six planets, ten moons, and comets,

mets, as yet unnumbered, are so combined together, so dependent one on another, and so much one family, that neither Venus, the Earth, nor any one part of this system can suffer alone, as ruin to one, would perhaps be ruin to all.

From nature's chain whatever link you strike,
Tenth or ten thousandth, breaks the chain alike.

It has been said above, that 450 Comets are recorded in history. Now if we consider, that most of these Comets descend more or less, into the sphere of the orb of the earth; and that out of those whose orbits have been calculated, there are only six whose least distance from the sun, exceeds that of the earth.—Yet still, no accident has happened that we can trace in the history of the most remote ages of the world.—May we not suppose, that room enough is assign'd in infinite space, by infinite power, for these orbs to move in, without falling foul of each other, as if left to the guidance of blind and blundering chance; and that we have nothing to apprehend from short-sighted predictions, or fanciful hypotheses.

It is therefore to prevent too great disturbances in the motions of Comets from the action of the planets and other Comets, says Sir Isaac Newton, that while the planets revolve all of them nearly in the same plane, the Comets are disposed in very different ones, and distributed over the whole system.

Maclaurin, too, has an admirable reflection upon this subject, in his paraphrase on Sir Isaac Newton's Principia. Speaking of the fatal effects that seemed possible to happen from the near approach of the
great

great Comet of 1680 to the earth, says, "it is not to be doubted but that, while so many Comets pass among the orbits of the planets, and carry such immense tails along with them, we should have been called by very extraordinary consequences, to attend to these bodies long ago, if their motions in the universe had not been at first designed and produced by a being of sufficient skill to foresee their distant consequences."

The present Comet totally disappeared about the 16th, being immersed in the rays of the sun, passing with great rapidity to its perihelion, from whence we are now (October) impatiently expecting its return.

By an article from Paris we are likewise informed that it became invisible there the same day on which it retired from us.

"The late Comet, so much talked of, was discovered at Paris the 8th of last August, by that indefatigable astronomer, M. Messier, whose assiduity and dexterity in observing the heavenly bodies, have long since deserved the highest praises from the learned; and he was honoured on this present occasion with a letter, wrote to him upon the subject, by one of the greatest monarchs in Europe, and geniuses of this age. The accurate observer followed observing the course of the Comet till the 16th of September, when it ceased to be visible by its approaching to the sun, being then near the alpha of Hydra. Its elements have been calculated by M. de la Lande, upon three equidistant observations of M. Messier, made on the 14th, 21st, and 28th of August, and are as follows:

"Incli-

“ Inclinacion of the orbit, 73 deg. 15 min. Descending node, 11 sign. 26 deg. 23 min. Perihelion, 6 sign. 11 deg. 28 min. Passage at the perihelion the 1st of October, at 9 and 22 min. Distance of the perihelion, 0,03104 ; that is to say, 32 times nearer to the sun than our globe ever is. From this it appears, that this Comet does not resemble any of the 57 Comets we know of; only the two seen in the years 1680 and 1689, did approach nearest to the sun. The last of them should have some likeness to this, were it not for the great difference between the distances of their respective perihelions, which take away any suspicion of this being the same.”

According to the perihilion distance given to this Comet by M. de la Lande, it might have been expected to return sooner than has been found by experience, as the velocity it would have acquired by such a near approach to the Sun, would have been accelerated, and its trajectory diminished.

As this Comet, in its way to the Sun, set westward of that luminary, it will rise from its rays on the other side ; namely, eastward of the Sun.

There is a popular division of Comets into three kinds ; namely, *tailed*, *bearded*, and *hairy* Comets, though this division rather relates to the different circumstances and situations of the same Comet, than to the phenomena of several.

Thus, when the light is westward of the Sun, and sets after it, the Comet is said to be *tailed*, because the train follows it in manner of a tail.

When

When the Comet is eastward of the Sun, and moves from it, the Comet is said to be *bearded*, because the light marches before it in manner of a beard.

And lastly, when the Comet and the Sun are diametrically opposite, (the Earth between them) the train is hid behind the body of the Comet, except a little that appears round it, in form of a *border of hair*.*

The tails of Comets are always on the side opposite to the Sun. This was first discovered by Apian, and has since been constantly confirmed by observation. They are best seen, and appear longest in southern climates, where the air is pure and sky serene. The Comet of 1759 appeared at Paris almost without a tail, and in England entirely without one. At the former place, it was with great difficulty that a slight trace of one could be distinguished of only one or two degrees in length; whereas at Montpellier, M. de Ratte found it to have one, April 29, of 25 degrees in its whole length, and 10 degrees of it extremely luminous; but M. de la Nux saw that Comet, at the isle of Bourbon, with a tail much more considerable; for the same reason that the zodiacal light is always visible there, and extends to above 100 degrees in length.

But there have been Comets, whose disk was as round, as well defined, and as clear as that of Jupiter, without either tail, beard, or coma; such was

* From this last appearance the word Comet is derived; as Κομηνος, *Cometa*, comes from Κομη, *Coma*, a head of hair.

one of the Comets that appeared in 1665, and, according to Cassini, that of 1682. Hence the tail of a Comet must not always be regarded as its necessary appendage, or principal characteristick.

Most Comets are visibly surrounded with an enormous atmosphere, often rising ten times higher than the nucleus, or solid body of the Comet. Sir Isaac Newton supposes it to be owing to the atmosphere of a Comet, that the nucleus is usually so ill defined; the most lucid parts of which not being above a ninth or tenth part of the whole breadth. In observations upon Comets, it is common to meet with accounts of bright spots in the middle of the nucleus, when in fact it should seem that the bright spot only was the nucleus, and the rest the atmosphere of the Comet.

M. de la Lande supposes very ingeniously, that as Comets are destined to pass from the most dreadful rarefaction and heat imaginable, to a cold density beyond conception, they are provided with these immense atmospheres, not only to protect them from such destructive excesses, but likewise to support and foment circulation, fluidity, motion, and life.

It has been remarked that Comets have different phases, like the Moon; and it was observed by Cassini, in the year 1744, that the body of that Comet was horned, shewing only half its disk.

The present Comet, seen through a good telescope, seems more to resemble a small Moon than a fixed star. The nucleus, or body of it, is large, but ill defined. The phænomena of the tail seems so much to favour an ingenious conjecture in the

Monthly Review, (Oct. 1767, p. 253.) that we cannot resist quoting it.

The book under examination is Dr. Priestley's History of Electricity: "Signior Beccaria has, "with great ingenuity, mixed sometimes with a "little spice of agreeable extravagance, the frequent concomitant of genius, ranged almost all the meteoric phenomena under the banners of electricity; from the *Will-o'-th'-Wisp* up to the *Aurora Borealis*. Had we room or inclination to theorise on this subject, at the same time that, with other electricians, we allowed the electric fluid to be the cause of this last phenomenon, we should be for extending its connections still further, and attempt to shew the possibility, at least, of its near relation to, if not its identity with, that luminous matter which forms the solar atmosphere, and produces the phænomenon called the *Zodiacal Light*; which is thrown off principally, and to the greatest distance from the equatorial parts of the Sun, in consequence of his rotation on his axis, extending visibly, in the form of a luminous pyramid, as far as the orbit of the Earth; and which, according to M. de Mairan's ingenious, and, at least, plausible hypothesis, falling into the upper regions of our atmosphere, is collected chiefly towards the polar parts of the Earth, in consequence of the diurnal revolutions, where it forms the *Aurora Borealis*. It would, we think, be no very bad hypothesis which should unite these two opinions, by considering the Sun as the fountain of the electric fluid, and the zodiacal light, the tails of Comets, the *Aurora Borealis*, lightning, and artificial electricity, as its various, and not very dissimilar modifications." Indeed the appearances

pearances of the tail of this Comet resembled electrical coruscations, more than any thing of which we have an idea, but mostly that produced *in vacuo*; as the flame seemed, through a telescope, perpetually to shoot out in strait lines, of a pale silver hue, lengthening and shortening at each instant, and forming frequently some of the configurations which the *Aurora Borealis* assumes.

There has been lately published a work by Dr. Hamilton of Dublin, under the title of Philosophical Essays; in which this idea seems extremely well developed. The subject and substance of the Doctor's second essay is so full to our purpose, that we shall condense it into an epitome, and present it to our readers.

Dr. Hamilton's Essay has for title, Observations and Conjectures on the Nature of the *Aurora Borealis*, and the tails of Comets.

The author differs from Sir Isaac Newton, concerning the nature of the tails of Comets; and endeavours to prove that they are composed of a lucid, or self-shining substance, and not a mere cloud or vapour, illuminated only by the Sun. This luminous matter he supposes to be the same with that which causes the *Aurora Borealis*, and the phænomena of electricity.

“ The great body of luminous matter which
 “ appears in an *Aurora Borealis*, says this Author,
 “ being so very extensive, and sometimes so very
 “ bright, must be visible to a spectator at a considerable distance from the Earth, and shaded
 “ from the Sun's light; and such a spectator
 G 2 “ would

“ would then see the Earth attended by a train of
 “ light in the form of a *tail*,” &c.

“ Electric matter appears to be of the same
 “ kind of substance which forms the *Aurora Bo-*
 “ *realis*, and the tails of Comets; by its having
 “ also that remarkable property of letting the
 “ rays of light pass through it, without having any
 “ sort of effect upon them.” “ Now the extra-
 “ ordinary rarity of Comets tails may be collected,
 “ says Sir Isaac Newton, from the stars shining
 “ through them; for the smallest stars are ob-
 “ served to shine without loss of splendor through
 “ tails which are of an immense thickness.” (*Prin-*
cipia, p. 513, edit. 2.) Dr. Hamilton has given
 to Comets a quite different employment from that
 allotted to them by Sir Isaac Newton, who made
 them water-carriers, loading them with vapours and
 moisture, to supply the losses of the several parts
 of the solar system through which they were de-
 stined to pass. But the Doctor, on the contrary,
 supposes it their business to collect and bring back
 to the Sun and planets, the electric fluid which is
 constantly flying off into the higher regions of the
 heavens, beyond the orbit of Saturn. “ We see
 “ this fluid rises from the earth into the atmos-
 “ phere, and is probably going off from thence,
 “ when it appears in the *Aurora Borealis*. And as
 “ this electric matter, from its vast subtilty and
 “ velocity, seems capable of making great ex-
 “ cursions from the planetary system, the several
 “ Comets in their long excursions from the Sun,
 “ in all directions, may overtake this matter, and
 “ attracting it to themselves, may come back re-
 “ plete with it, and being again heated and excited
 “ by the Sun, may discharge and disperse it among
 “ the planets, and so keep up a circulation of this
 “ matter,

“ matter, which we have reason to think necessary
 “ in our system.”

This does not seem far from Sir Isaac Newton's own opinion : for after supposing that the aqueous particles thrown off from Comets are taken up by the planets, as a supply of moisture, adds, “ I
 “ suspect, moreover, that that spirit which is the
 “ least, but the most subtile, and the best part of
 “ our air, and is necessary for supporting the life
 “ of all things, comes chiefly from the Comets.”

Dr. Halley, so long since as the year 1716, in his description of a remarkable *Aurora Borealis*, says, “ That the great streams of light so much
 “ resembled the tails of Comets, that at first sight
 “ they might well be taken for such ;” and afterwards adds, “ This light seems to have a great
 “ affinity to that which the effluvia of electric
 “ dies emit in the dark.” This was the doctor's conjecture ;—but both he, and Sir Isaac Newton, had so much of vaticination in all they said, that their conjectures are found by posterity to be little less than certainties.

But this striking similarity between the appearances of the tail of the Comet in a telescope, the *Lumen Boreale*, and the electric flash, was suggested to the writer of this historical sketch by the phænomena themselves, and not by the passages just quoted, of which he had not the least knowledge till after he had formed his opinion on the subject, but which indeed he was glad to have fortified by such good authorities.

It is with diffidence he mentions another telescopic appearance, as it may perhaps be only an
 optical

optical illusion. It seemed perceptible that the nucleus of the Comet had a very rapid motion on its own axis, and that there was a constant emission of electric sparks, or flashes from it at all points, which were instantly impelled with great violence towards the tail.

It has not as yet been positively determined by astronomers, whether this present Comet is one of those that have ever visited us before, at least since Comets have been so narrowly watched. But it is hoped that the worthy successor of the great Flamsteed, Halley and Bradley, by whom this Comet will doubtless have been well observed, will clear up this point, when he shall have had sufficient leisure for computing its elements, and comparing them with those of other Comets already computed. Out of above 50 Comets whose elements are known, the returns of no more than 5 or 6 have been foretold: which may be seen in the following table.

Former Appearances.	Years Period	Return exp. about	Orbits by whom calculated.
1532 : 1661	129	1789	Halley.
1531 : 1607 : 1682 : 1759	76	1834	Halley.
1264 : 1556	292	1848	Halley.
1165 : 1338 : 1512 : 1686	174	1860	Pingré.
1593 : 1762	169	1931	La Caille, Pingré.
44 Ant. C. 531 : 1106 : 1680	575	2255	Newton, Halley.

The Comets that are first expected, are placed first in the table. But it may be necessary to give the authorities upon which this table is constructed.

The Comet of 1661 observed by Hevelius, and that of 1532 by Appianus, (though there is a considerable

siderable difference in the places of their perihelions, which may easily be attributed to the imperfect and unskilful manner in which it was observed by Appianus) may be the same; and if Halley's conjecture be well founded, this Comet will again appear in the year 1789 or 1790. (*Hist. des Mat. par. Montucla.*)

Of the second Comet enough has already been said, under the article 1759. Unless we here bestow a few words upon the memory of M. Clairaut, who died May 3, 1765, aged but 52 years! in his elogium just published in the *Hist. de l'Acad. des Sciences*, there is this passage, equally appertaining to that great geometrician and to this article.—“Thanks to his labours, the opinion that
“Comets are planets, as ancient as the world itself,
“is now no longer a conjecture, but is regarded
“as a thing fully demonstrated.”

For the account of that which has the third place in the table, we are indebted to Mr. Dunthorne, (*Phil. Trans.* vol. 47.) who conjectures, that if the Comet which appeared in 1264 be the same as that which was observed by Paul Fabricius and others in the year 1556, and whose orbit Dr. Halley has compared, its period will turn out as above.

Concerning the Comet which occupies the fourth place in the table, we are indebted to M. Struick, who in his sequel to the description of Comets, (*Amst.* 1753) supposes the Comet of 1686 to be the same as that of 1512; “for one is upon record in 1338,—in 1165,—in 990,—in 817,—
“and in short 870 years before, that is to say,
“at the distance of 5 times 174 years; 53 years
“before Christ.”

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Our authority for the fifth Comet in the table, is given in the article for the year 1762.

And about the sixth or great Comet of 1680, which so alarmed the inhabitants of our globe in the last century, though the present is but little interested, so distant is the period. “ Yet, if it re-
 “ turn in 2255,” says Maclaurin, “ it will give a
 “ new lustre and evidence to Sir Isaac Newton’s
 “ philosophy, in that remote age. And should
 “ the inconstancy of human affairs, and the per-
 “ petual revolutions to which they are subject, oc-
 “ casion any neglect of our philosophy in the in-
 “ tervening ages ; this Comet will revive it, and
 “ fill every mouth again with this great man’s
 “ name. For it is one of the good effects which
 “ these great periods, and distant depending ob-
 “ servations promise, that they must contribute
 “ to preserve the relish for learning from the re-
 “ volutions to which it has been formerly subject.
 “ By them, distant ages are connected together,
 “ and perpetual matter is provided from time to
 “ time, for reviving the curiosity of mankind.”

And though the returns of no more than six Comets have, as yet, been calculated and foretold by astronomers ; yet, from the elements laid down, every age will recognize some of those which have visited us before ; till at length, the whole number of Comets in the solar system will be as well known to the inhabitants of the earth, as the five planets and their satellites.

One of them is already added to the number of revolving planets, which it is hoped will lessen the popular dread at the appearance of the rest. At this time of day it seems scarcely necessary to say,
 that

that the experience of many thousand years assures us that the solar system is so wisely framed and regulated, as not to be subject to accidents from the approach of Comets. But as two such able astronomers and mathematicians, as Whiston and Gregory, seem to encourage the belief that general ruin, or at least dreadful calamities, may be the consequence of a near approximation to the tail of a Comet, and as their opinions have no other foundation than conjecture and speculation, we may venture, without arrogance, to conjecture and speculate in our turn.

And first, let us speak to Mr. Whiston, who having (as has been mentioned in M. Maupertuis's Letter) with great learning and labour traced the great Comet of 1680 by different periods, of 575 years, up to the universal deluge, endeavours to account for that terrible catastrophe, by the water that was brought into our atmosphere by the tail of that Comet. We will, for a moment, grant it possible for Comets to quit the regular and stated course originally assigned them, and likewise, for the sake of Mr. Whiston's hypothesis, suppose the tails of Comets to be composed of aqueous vapours (an opinion which with, Dr. Hamilton's assistance, we have endeavoured to confute) yet still a powerful objection to the deluge having been occasioned by the tail of the Comet remains; namely, that vapours at such a great distance from the earth would be so rarified, that notwithstanding the Comet of 1744 had a tail 40 degrees long, the present Comet one of 42, and that of 1680 one of 70 degrees in length—if all the waters of this enormous tail were compressed into the density of those vapours in our atmosphere which coalescing, compose rain; they would be insufficient for the purpose of drowning

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the earth: since a single drop of water, rarified into vapour in our gross atmosphere, occupies 14,000 times the space it did, when condensed into water; and vapours sufficiently rarified to swim in Æther, though they formed a volume equal to the orbit of the Earth, would not furnish water enough to overwhelm it, which Sir Isaac Newton has demonstrated by proving that a cubick foot of water, at the distance of a semidiameter of the earth, would be so rarified as to occupy a space equal to the orbit of Saturn.

It has been said above by M. Maupertuis, that Dr. Gregory has established the Comets again in all their terrors. In supposing such dreadful consequences from a Comet's tail being in contact with our earth, &c.—if the learned Doctor were still living, one would be inclined to ask him, why the poor old ladies are still to be frightened with Comets? Do they either portend or occasion any thing worse than always subsists? When was the world without its plague, pestilence and famine; battle, murder and sudden death? Though Comets are doubtless placed in the heavens for some wise purpose, wholly inscrutable to us, yet, for any thing we have hitherto discovered, they have no more influence or effect upon our globe, or its inhabitants, than a *will-o'-th'-wisp* or *ignis fatuus*;—and yet every thing that is mischievous or disagreeable is placed to the account of the poor Comet.—If it rains, “it is the Comet;”—if the weather be hot, “it is the Comet;”—if it be cold, it is the same.—Pray let us be a little equitable, and allow that such things as abundant rain, intemperate heat, and intense cold, have happened in this climate before now, without the agency of a Comet; unless by

by some Comet that has appeared in disguise, like Mr. Bayes's army.

“ The war in the western parts of Europe, which
 “ continued from the year 1688 to 1697, has been
 “ the most obstinate and destructive of any re-
 “ corded in history; and yet no Comet has ap-
 “ peared, either immediately before or after; but
 “ on the contrary, one has been seen in September,
 “ 1698, when Europe was already freed from this
 “ war, and was on the point of establishing a last-
 “ ing peace between the Christians and Turks.—
 “ A Comet therefore has appeared between two
 “ treaties of peace, which have put an end to the
 “ ravages of war, in all parts of Europe, and
 “ greatly changed the general situation of affairs
 “ for the better: A Comet which restores those
 “ happy times, in which the temple of Janus is
 “ shut.” (*Pensées div. sur la comete de 1680*).

But superstitious people love to be frightened, and will be as angry with any one who endeavours to reason them out of their fears, as the inhabitants of *Neuf Chatel* were lately with one of their pastors, who, though in other respects an orthodox and devout Christian, yet could not reconcile to his belief the *eternity of hell torments*.—He would allow them to last a hundred thousand years, with all his heart,—but that would not satisfy his flock,—they prosecuted, persecuted, and pelted him. When the king of Prussia, their sovereign, hearing of it, and moreover that the minister was a worthy, well-meaning man, ordered them to desist, and suffer him to resume his function. But this enraged them ten times more,—they surrounded the good man's house, and would certainly have sent him to the other world, to enquire into the true state of de-

departed souls, had he not with great difficulty made his escape ;—and, at length, their sovereign, finding how fond they were of everlasting damnation, out of his great goodness, condescended to let them be damned to all eternity.—“ And I also, “ (says the author from whence this account is “ taken) consent with all my heart, and much “ good may it do them.”—*Lettre de M. Baudinet.*

It is amazing that such as are always ready to denounce divine vengeance, and to presage every species of calamity to the frightened inhabitants of the globe, upon the appearance of a Comet ;—that they, whose belief of the interposition of a *particular Providence* upon every trivial occasion, is so firm, never should think of extending their faith to the belief of a *general Providence*, which has secured the globe from contingent evils.

But there yet remain many who will have it that “ a Comet never appears without blood,”—and are sure to be right in their conjectures. For if Europe should enjoy a profound peace, they have only to look at Asia ; and if all be quiet there, they have still the other two quarters of the globe to fly to, which will, doubtless, furnish them not only with carnage enough, but also with every other kind of evil, both physical and moral, their hearts can wish, to confirm them in their opinion.

But those who are unwilling to see God, but in vengeance and destruction, should try to discover him in his goodness and protection from general calamity, by that wise order of his Providence, so visible in the wonderful and stupendous arrangement of the universe.

T H E E N D.

Bayerische
Staatsbibliothek
München

P O S T S C R I P T.

London October 25, 1769.

THE Comet is returned.—It was seen last Monday, by several people, in different parts of the kingdom, at half an hour past six in the evening; west by south, about nine degrees high. It appears with a *Coma*, but without a tail: perhaps the tail may be visible in a clearer air. The Comet is at present more distant from us than the Sun, and its tail oblique to us, whereas, in its former appearance, it was perpendicular.



An Essay towards a history of the principal Comets since 1742

London 1769

Astr.p. 48

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